1976

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Joseph Anthony Gliem

Iowa State University

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Effectiveness of a student reference in teaching safety to high school vocational agriculture students

by

Joseph Anthony Gliem

A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of The Requirements for the Degree of DOCTOR OF PHILOSOPHY

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CHAPTER I

INTRODUCTION

"For centuries accidents have plagued man. Family goals and aspirations are interrupted when human resources are destroyed or disabled so as to be nonproductive," (Bettis, 1972, p. 1).

With a 16% increase in death rates due to accidents in agricultural industries between 1960 and 1970, as identified by the National Safety Council; it would appear evident that something needs to be done concerning research for better safety education. Judy, as early as 1932, was suggesting the need for more safety education in the industrial arts shops in Iowa and for instruction relative to the safe use of tools. He felt that safety methods and devices used at that time were not adequate or there would not have been such a high accident rate.

Bettis (1972, p. 16) further pointed out the need for safety instruction when he said:

…it is imperative that the safe as well as correct way to perform a task be taught the first time the student is introduced to the learning experience. Safe working conditions and safe tools plus rules and regulations must also be present.

Stone (1953, p. 38) stated:

It would seem, from comments and letters sent in by instructors regarding this accident-reporting program that many instructors are not cognizant of their responsibility in regard to the matter of instilling safe habits in the minds of their students. Several instructors have listed student carelessness as the cause of an accident and apparently did not look any
further into the matter. However, carelessness in itself is not a cause for an accident. Rather, it is a result, in many instances, of an instructor's failure to properly instruct his students in safe work-habits.

In his discussion, he also said:

There is an urgent need for more safety education not only for the student, but also for the instructor. Responsibility for providing a safe place in which to work rests squarely upon the instructors' shoulders, and one of his primary obligations to society is to turn out individuals who have an abiding faith in the value of safe work habits which will carry over into everyday life.

The nature of instruction in vocational education in the public schools has become quite diversified, especially within the last decade. The decade of the sixties was one in which vocational education received renewed attention, with the passage of the Vocational Education Act of 1963 and the 1968 Vocational Education Amendments. As a result of the acts, many changes have been implemented in all programs of vocational education.

The vocational agriculture curriculum in the public schools, like those of other vocational programs, has undergone many changes since the passage of the Vocational Education Act of 1963 and the 1968 Vocational Education Amendments. Before passage of the acts, it was realized that the traditional production agriculture curriculum was not meeting the needs of many of the students enrolled in vocational agriculture programs. As a result, the acts encouraged the expansion of high school
vocational agriculture curriculums so that they would help prepare students for entry into and success in occupations other than production agriculture that require knowledge and skill in agriculture.

The agricultural mechanics curriculum, being a part of the total vocational agriculture program, has also been expanded. The subject matter phase of the agricultural mechanics curriculum in particular has been weakened in content due to the curriculum expansion. Henderson (1967, p. 198) had the following to say:

When vocational agriculture expanded from farm shop into agricultural mechanics, very few teachers and administrators realized how much of a subject matter weakness existed. True, there is much information on most subjects, but it is widely scattered and difficult to organize into effective teaching material. Some of the information is in language that a teacher cannot interpret without expert help.

There is some evidence that key leaders in vocational agriculture are gradually becoming aware of the seriousness of this situation. Several have reported the great need for well-prepared agricultural-mechanics subject matter.

Because of the need for additional safety materials and the awareness of the problems that exist in agricultural mechanics subject matter by Henderson and others, attention has been directed toward the development of instructional materials for safety in agricultural mechanics. This writer has been engaged in the preparation of an agricultural mechanics student reference on the topic of ladder safety (See Appendix A). As was true of
much of the agricultural mechanics subject matter material, there were fragments of information on ladder safety, but it was widely scattered and extremely difficult to organize into an effective teaching unit. Thus, the problem was to identify sources of information, and then to rearrange and rewrite the material so that it could be used to effectively teach a group of high school students. To achieve this goal, objectives were formulated, and then materials were selected and rewritten to accomplish these objectives. The student reference had many illustrations and pictures included so as to help students better understand the material they were reading. The main objective of this study was to evaluate the effectiveness of this prepared safety instructional material on agricultural mechanics in the vocational agriculture curriculum.

Statement of the Problem

The purpose of this study was to evaluate the effectiveness of the student reference prepared by the writer in the teaching of safety in agricultural mechanics to high school students enrolled in vocational agriculture classes in Ohio. More specifically, the study attempted to evaluate the effectiveness of the student reference in terms of the following dependent variables: 1) student performance on a cognitive test, 2) the number of other safety references used by the teacher, 3) the amount of preparation time used by the teacher, 4) the amount
of time needed to teach the safety unit, and 5) the amount of time students spend outside of class on the safety unit. The independent variable manipulated in the study was the extent to which teachers and students had access to the student reference. There were three levels of the independent variable as follows: 1) both teachers and students received the student reference, 2) the teachers only received the student reference, and 3) neither the teachers nor the students received the student reference. A measure of these dependent variables would be helpful in the development of future instructional materials.

Need for the Study

Due to the expansion and implementation of curriculum in high school vocational programs, the need for instructional materials has increased. As a result of this need for additional instructional materials and the availability of funds, many states and organizations have entered the instructional materials market and are now preparing and distributing instructional materials that cover a variety of subject matter areas and topics.

With the increased amount of instructional materials available, one has seen an influx of such materials into the educational market. Many people are using these instructional materials, but few have been evaluated as to their effectiveness in teaching students, in increasing cognitive knowledge, and in
bringing about the desired behavioral changes in students as determined by the teachers using the material.

Urbanic (1971, p. 38) brought out the need for evaluation of instructional materials when he said:

Research concerning the evaluation of curriculum materials, other than programed instruction units and films, is limited, especially in vocational education.

He went on to say:

Those persons involved in preparing instructional materials, such as source units and student references, often wonder about the effectiveness of the materials in terms of pupil learning. Although several curriculum materials services are producing instructional materials for vocational education programs, it is apparent that few of these materials are tested for their effectiveness.

Ridenour (1965, p. 88) revealed the need for evaluation of curriculum materials when he said:

The effectiveness of educational materials in the teaching-learning process will be unknown until the materials have been tried in the classroom and evaluated in terms of whether or not they have brought about the behavior changes in students that were specified in the educational objectives. The work of a curriculum materials service should be directed by both formal and informal evaluative procedures which indicate the kinds of materials which are most effective. Such evaluation procedures should provide firm direction for the preparation of materials. If such procedures were lacking much direction would come from untried opinions of staff members and teachers.

It appeared that a study was needed to evaluate the effectiveness of the writer's student reference in teaching ladder safety in agricultural mechanics. This study attempted to evaluate
the effectiveness of this student reference in terms of the extent to which teachers and students had access to the student reference.
CHAPTER II

REVIEW OF RELATED LITERATURE

Need for Safety Education

The need for safety education became quite apparent when one considered comments from international organizations like the International Labour Office when it said (1970, p. 3):

All industrial accidents are - either directly or indirectly - attributable to human failings. Man is not a machine; his performance is not fully predictable and he sometimes makes mistakes. A mistake may be made by the architect who designed a factory, the contractor who built it, a machine designer, a manager, an engineer, a chemist, an electrician, a foreman, an operator, a maintenance man - in fact, by anyone who has anything to do with the design, construction, installation, management, supervision, and use of the factory and anything in it.

Thygerson (1972, p. 3) also supported the concept of safety education when he said:

Like other events, accidents are caused, and therefore, can be controlled when their causes are identified and understood. Frequently, accidents are not unforeseeable because most of them are not chance occurrences but rather reflect inefficiencies in the system. Accidents occur because people make mistakes. The statement that "80 percent of accidents are caused by human beings" may be simplistic and require confirming research. Human error frequently underlies unsafe conditions such as poor design, construction, and maintenance; therefore, most accidents are still attributable to human error.

The International Labour Office gave support to Thygerson's comments on causes of accidents when it concluded (p. 25):
In safety literature two groups of accidents are often distinguished: those due to technological, mechanical or physical causes, and those due to unsafe behavior by the worker. To the first group belong accidents caused, for example, by defective parts, unguarded machines, damaged electric cables and worn-out hoisting ropes. To the second group belong those resulting from absent-mindedness, negligence, fool hardiness, or ignorance of risk. The first group is often considered to compromise 15 per cent. of all accidents, the second 85 per cent., and the conclusion is accordingly drawn that attention should be concentrated on the latter group.

Thygerson further commented (p. 19):

The accident picture in the United States is grim; yet it is fair to assume that without organized safety efforts and safety education, America's accident record would be even more shocking than it is. Following heart disease, cancer, and strokes, accidents are the fourth principal cause of death in the United States.

The International Labour Office reported that in recent years there has been a growing realization in a number of countries of the advantages of giving some safety education in schools and colleges so as to ensure that entrants into industry have at least an idea of the dangers awaiting them and the means by which they could help to obviate them.

The President's Conference on Industrial Safety also made recommendations concerning the development of safety education. One was that teachers, authors, and publishers should be encouraged to include appropriate safety references in textbooks, laboratory manuals, and other instructional materials.

There are two general ways by which one can influence the actions of others. One is to concentrate on altering their
ideas, feelings, or goals; the other is to change the situation, thereby indirectly affecting their goals, ideas, and feelings. One often combines these approaches through modification of human behavior. Behavior modification usually begins with education and continues down through various modes of influence if the preceding one is not effective.

Dr. William Haddon, Jr. (1967) gave an example of this continuum of behavior modification in accident prevention when he said (p. 598):

The prevention of accidents through the modification of human behavior is usually approached through (1) education, (2) coercion, and (3) legal sanctions. In general, when educational efforts have failed, coercion has been tried; when this has failed, legal sanctions have been endorsed. However, when neither education nor coercive measures have proved effective, the implementations of the last step has often taken decades. This was seen in the quarter-of-a-century lag between the development of the railroad air brake and automatic coupler and the passage of legislation that forced their general use - a period in which tens of thousands of railroad workers were killed and many more injured.

Florio and Stafford (1969) further supported the need for safety education when they said (p. viii - ix):

Preventing accidents is not a simple matter, for so many variables affect the accident rate that it is difficult to determine the most effective remedial action. But since human error is probably the outstanding cause of 85 percent of all accidents, education for safe living seems the best approach to the problem of minimizing them. Excellent results have already been reported in those areas that have received primary-emphasis. This...holds that the scope of safety education must be enlarged to embrace all the times and places of ordinary life - the home, the
factory, the farm, the school, and the community - man's hours of work and his hours of leisure.

They further stated (p. ix):

Few high schools, however, have overall safety programs comparable in effectiveness to those offered in the lower grades. At the secondary level, attention has been focused on driver education, and excellent results have been achieved, but there is a clear need for more comprehensive instruction....American educators recognize that education for safe living is an integral part of the school's responsibility to society. The challenge of preventing accidents today is greater than ever. Unfortunately, however, corresponding attention has not been given to preparing teachers for safety education, so that few are qualified for their work. Too often, for the sake of administrative convenience, the tasks of teaching safety has been thrust upon a teacher because he or she has a free period or because he "gets along well with the students."

In 1958, Hannaford conducted a study to investigate the relationship between safety attitude and accident experience of industrial workers on the job. He found a positive correlation of .32 between male employee industrial safety attitude and accident experience during the five-year duration of the study. Individuals having had two or more disabling injuries had a positive correlation of .45. In analyzing the differences among the three group means (accident free male employees, those with one or more disabling accidents, and those with two or more disabling injuries), he found a significant difference at the .01 and .05 alpha levels of significance. He concluded that there was a definite need for safety education to help offset potential accidents among workers.
Birnbach (1948) studied junior high school students in an attempt to determine and compare the psycho-physical qualities of the accident-repeater and the accident-free student. Students were tested in their regular classes in the school on forty-three different variables. Of the variables studied, safety knowledge was the most significant when compared to accident experience. It was found that 41.3 percent of the accident-repeaters failed the cognitive test on safety, whereas none of the accident-free students failed the test.

Birnbach (p. 45) concluded:

...(2) Possessing adequate safety knowledge is an accident deterrent providing the individual does not suffer from any serious personality maladjustments or serious physical defects. (3) Intelligence as a factor is not to be regarded as an important requisite in accident prevention. (4) When thwarted, the typical defenses of the repeater is his attempt to dominate by physical means, recklessness, bravado and evasion. These are his springboards to accidents. (5) Accidents are produced usually as the result of a combination of factors rather than any one factor.

Safety Review of Related Literature

Bettis (1972) in his review of literature made the following comments (p. 17-18):

...(1) that safety instruction should not be treated as something separate and apart from the teaching of industrial art skills but rather as a part of the step-by-step instruction in those skills, (2) that the instructor must be as diligent in observing safe practices as he expects his pupils to be, (3) that certain safe practices which are common to most individuals and many life situations should be incorporated in every school shop safety instruction
program, (4) that a common code of safety rules or regulations should be developed for each type of shop for a general understanding of the requirements by all students and instructors, (5) that safety instruction should be active and whenever possible should involve real problems, (6) that safety instruction should constantly be interpreted in terms of school and common industrial activities, (7) that supplementary materials such as posters and pamphlets are essential to sustain interest in the safety program but should be changed often, and (8) that adequate and constant supervision of student safety activities by instructors is fundamental to successful safety instruction.

In 1972, Nichols studied the relationship between unsafe student behavior in the laboratory and selected psychological factors contributing to unsafe behavior. The findings of his study resulted in his concluding (p. 84):

...that as a student's knowledge of metal working increases, he is more likely to perform metal-working activities in a safe manner....Students with high achievement in metalworking appear to have a greater desire to perform in a safe manner than students with low achievement.

Anderson (1967) used caricature safety booklets to supplement the traditional machine woodworking safety instruction. Instruction was given on six power woodworking tools. Using a nonequivalent control group design, teachers were asked to present the traditional safety instruction to both the experimental group and the control group. In addition, teachers were asked to supplement the safety instruction to the experimental group by using the caricature safety booklets. The study was also designed to measure retention of safety information by having students retested three weeks after the completion of the safety
Findings of the study showed that the experimental group scored significantly better on three of the six safety units, and that there was a significant difference between teachers as measured by knowledge gained during the course of the study. Similar results were observed when retention of safety information was used as the criterion measure. As a result of the findings, it was concluded that the use of safety booklets could result in greater knowledge gain and retention of safety instruction as compared to the traditional method. However, it was also shown that safety instruction was still largely dependent upon the teacher's method of presentation. It should be pointed out that due to lack of random selection of participants into the study, the findings should not be generalized to students outside the groups involved.

Using a pretest-posttest control group design, Bettis (1971) conducted a study to determine the effectiveness of prepared study guides in teaching the safe use of power woodworking equipment. A true-false test was used to measure student knowledge gained on power tools and their safe use. A laboratory practicum was also used, utilizing evaluators, to determine the students' ability to safely and effectively use power tools.

A study guide was developed for each of eight different power tools to be used as a supplement with regular teaching of the safe operation of these tools in the laboratory. The
power tools used in the study were: portable circular saw, table saw, radial arm saw, band saw, jointer, portable drill, drill press, and the router. Each of the study guides consisted of: 1) part identification, 2) safe operational procedures, 3) general safety practices, 4) completion questions, and 5) suggested reading references.

The study guide for each power tool was given to the students in the treatment groups prior to the demonstration by the instructor of the safe use of that power tool. The students were asked to read the study guides and answer the completion questions. The control groups were taught in the conventional method exactly the same except they did not receive the study guides.

Results of the study indicated that prepared study guides could be used effectively in teaching power tool safety. The findings showed that the safety scores were significantly higher for the treatment groups for six of the eight power tools. The total safety score for all power tools combined and total laboratory score, which included both the safety and performance scores, was also in favor of the treatment groups. Here again, it should be noted that the findings of this study cannot be generalized beyond the experimental subjects due to the lack of random selection of students into the study.

Herr (1971) studied the effectiveness of a program of agriculture in elementary schools with emphasis on safety,
sanitation, and conservation. His purpose was to evaluate the effectiveness of a program of agriculture in the elementary schools in terms of change in pupil interest, attitude, and knowledge. A resource unit was developed as the nucleus of the instructional material used in the program. Efforts were also made to determine which of three teaching methods achieved the greatest improvement in these areas. He used a pretest-posttest control group design where sixth grade classes were randomly assigned to one of four groups (subject matter specialist using the resource unit, homeroom teacher using the resource unit, homeroom teacher not using the unit, and no formal program of any type).

Results of his findings indicated that: 1) a program of agriculture does affect significant changes in attitude and knowledge, but not in interest, 2) students taught by the subject matter specialist using the resource unit had significantly higher scores in achievement at the .01 level than students taught by the homeroom teacher using the resource unit, 3) homeroom teachers using the resource unit had students with significantly higher scores in both attitude and achievement than students taught by the homeroom teacher using no resource unit, and 4) students taught by the homeroom teacher using no resource unit had significantly higher achievement scores than those students receiving no formal program.

Beckham (1969) used a nonequivalent control group design to
compare two methods of teaching safety in using machine tools in a college level wood laboratory. The experimental method employed techniques of programmed self-paced instruction whereas the control method consisted of the traditional lecture-demonstration instruction.

Findings of this study showed: 1) that the self-paced program of instruction was significantly more effective at the .01 level than the traditional method of teaching safety in using tools in the wood laboratory, 2) that safety practices in operating woodworking machines may be adequately taught by either method of instruction, and 3) that the instructor had significantly more time at the .05 level to devote to individual students when programmed instruction was used.

Linhardt (1971) conducted a study to determine the effect of selected instructional variables on student attitude toward shop safety. He used a pretest-posttest control group design using the independent variables of: 1) a three-week intensive course on shop safety, 2) a three-week intensive course on shop safety plus a series of films on safety, and 3) a three-week intensive course and a series of safety films plus enforced shop safety.

His findings resulted in the following conclusions being stated (p. 5122-A):

1. Although the conventional lecture demonstration method of teaching shop safety has been used for
a number of years, this method did not change safety attitude significantly and should be supplemented with actual accident films.

2. Since there was little or no correlation between intelligence and safety attitude, it would seem that scholastic aptitude or intelligence, within the limits of intelligence and SCAT scores in the study, are of no serious consequence in developing safety attitudes.

3. Those students who are mechanically inclined, do not possess attitudes which are significantly more favorable toward safety than those who are less mechanically inclined.

4. Students working in the shop under strict supervision in this study did not maintain their attitudes toward safety. The attitudes seemed to regress toward the attitudes held before they were changed by the intensive instructional shop safety unit and a series of safety films.

5. Students' mechanical comprehension or scholastic aptitude do not appear to be significant factors in changing safety attitude.

Dennis (1972) conducted a study to compare the positive, the negative, and the combined positive-negative approaches to teaching safety practices. He used a pretest-posttest control group design using four treatment groups. A test for retention after three weeks was also included in the study. The treatment groups used in the study were as follows: 1) safety lesson using only positive safety instruction (example: When in this situation, do..., because of...), 2) safety lesson utilizing only negative safety instruction (example: Never do... in this situation, because...might happen.), 3) safety lesson using a combination of positive and negative safety instruction, and
4) a control group that received no safety instruction.

The following findings resulted from the study: 1) the combined positive-negative instruction produced significantly higher gains in the knowledge of safety than did the positive instruction, the negative instruction, and the control. The control situation was significantly less effective than any of the three instructional treatments, and 2) the retention of safety knowledge for the combined positive-negative instruction resulted in significantly higher gains than did the other treatment situations.

Instructional Materials Review of Related Literature

Very few textbooks have been evaluated in the classroom except on a comparative basis with other similar textbooks. There were various reasons given for this lack of research, however, Lumsdaine (1963) brought these reasons together in a logical explanation when he said (p. 586):

The usual textbook does not control the behavior of the learner in a way which makes it highly predictable as a vehicle of instruction or amenable to experimental research. It does not in itself generate a describable and predictable process of learner behavior, and this may be the reason why there has been very little experimental research on the textbook.

Tyler contended (1957, p. 69):

The process of evaluation is essentially the process of determining to what extent the educational objectives are actually being realized by the program of curriculum and instruction. However,
since educational objectives are essentially changes in human beings, that is, the objectives aimed at are to produce certain desirable changes in the behavior patterns of the student, then evaluation is the process for determining the degree to which these changes in behavior are actually taking place.

There has been much attention given to behavioral objectives within the past several years. Due to this increased attention, an awareness has been developed of the need for behavioral objectives in designing curriculums as well as in the development of curriculum materials. Burns (1967, p. 1) supported this contention by the following statement:

There is no more important contribution being made by modern learning theorists and educational technologists than the development of a sound body of knowledge related to the conceptualization, development, and implementation of learning objectives.

Mager and Beach (1967, p. 1) felt that the key question to be asked throughout the process of developing subject matter was, "What kind of things should the student be able to do at the end of the course that will most facilitate his becoming a skilled craftsman in the least amount of time?" These authors continued, "Course objectives represent a clear statement of instructional intent, and are written in any form necessary to clarify that intent."

It appeared that there was a relationship between the need for specifying behavioral objectives and subsequent evaluation of curriculum materials. Gagne (1967, p. 21) supported this when he said:
In sum, the method of specifying a curriculum by deriving a hierarchy of capabilities, beginning with educational objectives that describe human performance, seems to have some important implications for research. First, it is a systematic method for designing curricula on the basis of empirical evidence of their feasibility. Such evidence can be obtained initially even before design is undertaken, and can continue to provide corrective inputs to successive stages of the curriculum-development process. In addition, however, it seems evident that this method of specifying content has some useful methodological implications for research on the learning of school subjects. When a learner's capabilities can be measured in terms of mastery of the specified units of a curriculum a desirable degree of control is attained which then makes possible the study of learning effectiveness under conditions involving experimental variations to timing, sequence, incentive, and other variables. This advantage applies to the study of learning of extended sequences of content having a practical resemblance to those encountered in school situations, and also to the investigation of individual differences in learning.

In an article by Ebel (1970, p. 172), he argued that "to stress behavior as the objective is somewhat inaccurate and misleading." He felt that the measuring of immediate behavior based upon stated objectives would not give consideration to the effects of learning for the future. He went on to list the following as difficulties with behavioral objectives:

1. One of these is the difficulty of knowing precisely what concept means.

2. Another difficulty is that the behavior specified in these definitions is seldom the real objective of the instruction.

3. A third problem is that of specifying the behavioral objective in sufficient detail.
4. A fourth problem is that of specifying an appropriate level of skill or competence in the behavior.

Ebel also contended that when one placed too much emphasis on stating behavioral objectives, "There is always the danger that stated objectives may impose a rigid formality on teaching."

Legg (1962) conducted an experiment to compare the effectiveness of programmed-instruction and lecture-discussion methods of teaching agricultural finance and credit to vocational agriculture students. A pretest-posttest control group design was used in the study. A teaching unit, consisting of eight suggested lesson plans and a 53-page student information booklet, was developed to teach the unit by the lecture-discussion method. Preparation of the programmed-instruction booklet was done by rewriting and arranging the instructional material into a sequence of short steps or frames.

The findings showed a significant difference at the .01 level of significance between the mean test scores of students taught by the lecture-discussion method as compared to the students taught by the programmed-instruction method in favor of the lecture-discussion method. It was also found, although not significant, that teachers in the lecture-discussion group used an average of twelve hours of instruction while the programmed-instruction group teachers only used an average of five hours to complete the unit.
Although there was no significant difference from pretest to posttest, the students did make a gain in each of the methods of teaching. The fact that there was a significant difference between the test scores of students taught by the programmed-instruction method favoring the lecture-discussion method points out that student references were useful in lecture-discussion classes. Since few schools were utilizing programmed-instruction, it appeared that the production of student references should continue.

In a study designed to test the relative effectiveness of two methods of presenting instructional units to teachers, Ehresman (1966) randomly assigned teachers to two groups. One group had access to a resource unit entitled: Agricultural Cooperatives, A Teacher's Guide for Instructional Planning and the other group (the control) only had access to a packet of materials that they could use or not use, since the resource unit was not provided. The findings showed no significant difference between the posttest scores of the two groups; however, both groups showed gains from pretest to posttest and the fact that the experimental group score was slightly higher indicates that the availability of instructional materials could have some favorable connection with the student learning that takes place in the classroom.

Urbanic (1971) evaluated the effectiveness of a student reference in teaching ornamental horticulture to high school
students. A part of his study was also aimed at determining the attitudes toward a student reference with those teachers and students using the reference and those teachers who had not used the reference. He used the posttest-only control group design in which teachers indicating a willingness to participate in the study were randomly assigned to the experimental group or the control group. Those teachers in the experimental group received behavioral objectives and student references designed to teach the subject matter stated in the behavioral objectives. Those teachers in the control group received behavioral objectives, but did not receive the student references and were not told that student references were being used.

Urbanic (pp. 117-118) reached the following conclusions based on the findings of his study:

1. The use of the student reference did not bring about an increase in the amount of learning by vocational horticulture students.

2. The use of the student reference did not significantly reduce the class preparation time for vocational horticulture teachers.

3. The use of the student reference did not significantly reduce the number of periods needed to teach the unit for vocational horticulture teachers.

4. The use of the student reference did not significantly reduce the number of other references used by vocational horticulture teachers.

5. Teachers of vocational horticulture were more favorable toward the use of student references than were their students.
Urbanic (p. 119) concluded:

...that even with "exposure only" use of the Plant Growth unit, the teachers using the reference used fewer other references than the teachers in the control group. The class preparation time of the experimental group teachers was reduced slightly, but not significantly, their students scored as well as the students not exposed to the reference and they spent about the same number of class periods teaching the Plant Growth unit. Therefore, it can be concluded that teachers feel that references are useful and needed, but as long as curriculum materials are produced and only made available to teachers without proper instruction as to their use, these curriculum materials probably will not lead to substantial increases in students' learning, as measured by scores on objective tests, nor will they substantially reduce the number of other references used, the class preparation time or the number of class periods required to teach a specific unit.

This study, as mentioned by Urbanic, was limited by the fact that teachers in the experimental group were using student references without instructions on how to use them.

Barker (1967) conducted a study that involved the measuring of the relative effectiveness of instructional units designed to enhance student understanding of profit-maximizing principles when used in classes of vocational agriculture. He used the posttest-only control group design in which teachers indicating a willingness to participate in the study were randomly assigned to one of three groups. The three groups were identified as follows: 1) Control group, these schools taught farm management in the traditional manner; 2) Pilot-integrated, these schools used the developed instructional units on profit-maximizing principles in conjunction with other subject matter; 3) Pilot-block, these
schools used the developed instructional units on profit-maximizing principles exclusively. All teachers were familiar with the study and close contact was kept with the schools during the study. Those teachers using the instructional units were given training on how to use them. Note this was in contrast to Urbanic's study where the teachers did not receive instructions on how to use the student reference.

Barker (pp. 162-163) arrived at the following conclusions:

1. The developed instructional units enhanced student understanding of profit-maximizing principles to a greater degree than did the traditional technique of teaching farm management used by control schools.

2. Students in the pilot-block group showed a greater understanding of profit-maximizing principles than did those students in the pilot-integrated group.

3. Pilot-group and Pilot-integrated group teachers found the instructional units challenging, time-consuming, and requiring extra study, yet this extra preparation and teaching efforts tended to result in greater student interest and achievement.

4. Teachers who appeared to have the greatest appreciation of profit-maximizing principles, the developed instructional units, and the discovery method of teaching tended to more effectively employ the new technique of farm management instruction in classes of vocational agriculture.

Barker (p. 165) concluded with the following recommendation:

...further attention be given to the development of instructional units concerning the basic principles in other areas of the vocational agriculture curriculum.

It should be noted that the findings of this study, like those of Urbanic's study, were limited because of the threat of
sampling bias to external validity. The following limitations were also noted by Barker (pp. 13-14):

1. The lack of a common understanding of what should be included in farm management instruction for vocational agriculture.

2. The skill of teachers to effectively use the inductive process of the discovery approach to the understanding of profit-maximizing principles.

3. The time and ability of pilot-school teachers to understand and use the developed instructional units as designed in a block or integrated technique.

Shontz (1964) compared the educational effectiveness of three methods of teaching agricultural occupations information associated with land use and conservation. He used the pretest-posttest control group design where schools were randomly assigned to one of three groups. The groups used were as follows: 1) Integrated method, teachers in this group were furnished with a teaching plan combining information on agricultural occupations and on land use and conservation. They were also provided with a list of additional references that could be used; 2) Separate Method, teachers in this group were furnished with a teaching plan for agricultural occupations and a teaching plan for land use and conservation and were to teach these units separately. They were provided with the same list of references as those using the integrated method; 3) Own Method, teachers in this group were asked to use their customary teaching procedures to teach the problem areas they
were supplied with. They were not provided with a list of reference material.

Shontz (p. 5256) concluded the following:

1. The integrated and separate units teaching methods did not differ significantly in student achievement on a test of agricultural occupations and a test of land use and conservation, both were superior to the instructor's own method.

2. The increases of test scores over pretest scores for agricultural occupations and for land use and conservation were significant for the integrated and separate units method, however, for the instructor's own method, there was no gain on the agricultural occupations test but there was a significant increase in the land use and conservation test.

3. The organized instructional units were essential for effective teaching of agricultural occupations information related to land use and conservation.

It should be noted that these findings, as in the other studies, should only be generalized to a particular population.

Wilson (1971) evaluated the effectiveness of different teaching materials on student achievement in learning the basic skills and knowledge in applied electricity for the farm and home. A pretest-posttest design was used to determine achievement.

The results showed that the mean test scores of students taught by the resource unit method were significantly higher than mean test scores of students taught by the teaching outline. The findings also showed that significant gains were made in knowledge of basic electricity from pretest to posttest in both groups.
CHAPTER III

METHODOLOGY

Hypotheses

The review of related literature indicated differences in findings in being able to detect a significant difference in student learning as a result of students using student references. It did, however, provide the rationale for the development of the following hypotheses:

Hypothesis 1. The use of a student reference on ladder safety in agricultural mechanics with students enrolled in the vocational agriculture curriculum will result in higher class scores on an objective test for classes where the teachers and students receive the reference as compared to classes where the teachers only receive the reference; whereas, classes where neither the teachers nor the students receive the reference will have lower class scores on an objective test than either of the other two classes.

Hypothesis 2. Class preparation time will be less for teachers in classes where the teachers and students receive a copy of the student reference on ladder safety in agricultural mechanics as compared to teachers in classes where the teachers only receive a copy of the student reference; whereas, teachers in classes where neither the teachers nor the students receive the student reference will require more preparation time than either of the other two groups of teachers.

Hypothesis 3. Class time required to teach the ladder safety unit will be less for classes where the teachers and students receive the student reference on ladder safety in agricultural mechanics as compared to classes where the teachers only receive the student reference; whereas, classes where neither the teachers nor the students receive the student
reference will require more class time to teach the safety unit than either of the other two classes.

Hypothesis 4. The number of other ladder safety references used by teachers will be fewer in classes where the teachers and students receive the student reference on ladder safety in agricultural mechanics and in classes where the teachers only receive the student reference as compared to the number of safety references used by teachers in classes where neither the teachers nor the students receive the student reference.

Hypothesis 5. Student time required to complete the ladder safety unit will be less for classes where the teachers and students receive the student reference on ladder safety in agricultural mechanics as compared to classes where the teachers only receive the student reference and classes where neither the teachers nor the students receive the student reference.

Definition of Terms

The terms below have been defined in order to provide a common basis for the understanding of this study.

Class preparation time - The amount of time required for the teacher to prepare the unit to be presented to the class.

Class time - The amount of time spent in class by the teacher and/or students to complete the unit.

Intact class - A class composed of all students normally enrolled in a course that was selected in total. That is, all students in the class were included in the study because their class was selected and the class was the experimental unit.

Student reference - A publication written as a textbook to be used by students as their primary reference to supplement the
teacher's classroom presentation and/or to be used for supervised study.

Student time - The amount of time the student uses outside of class to complete the unit.

Population and Sample

Since the student reference on ladder safety was intended to be used primarily by sophomore students in high school vocational agriculture classes, sophomore students enrolled in the vocational agriculture curriculum and their teachers in Ohio were the target population for the study. However, such an attempt to use individual students or intact classes of students throughout Ohio was unrealistic in terms of the resources available to the investigator. Therefore, intact classes of sophomore students enrolled in vocational agriculture in Southwest Ohio were used as the experimental units.

Thirty schools having sophomore vocational agriculture classes were randomly selected from a frame of seventy-three schools to participate in the study. The frame was developed from the records of the Agricultural Education Service of the Department of Vocational Education, Ohio State Department of Education. The investigator also randomly selected thirty alternate schools having sophomore vocational agriculture classes, keeping them ordered, to be used as replacements in the event that some of the original thirty schools selected could not participate in the study. Four
of the alternate schools had to be used since four of the original schools selected could not schedule the ladder safety unit into their curriculums when needed. The first four alternate schools contacted agreed to participate. In analyzing the reasons why the originally selected schools could not participate in the study, the researcher could see no reason to suspect that the experimentally accessible population was different from the target population. Thus, generalizations were made to sophomore students and their teachers in high school vocational agriculture classes in Ohio.

After randomly selecting the experimental units, the assignment of these units to experimental groups was done randomly. The treatment levels (student reference to teachers and students, student reference to teachers only, and the control group where neither the teachers nor the students received the student reference) were then randomly assigned to the three experimental groups.

The Design

The design used in the study was the posttest-only control group design as described by Campbell and Stanley (1971, p. 13). This was a true experimental design and is graphically represented below:
These symbols are defined as:

- **R** indicates random assignment to separate treatment groups and random assignment of treatment levels to groups.
- **X<sub>1</sub>** treatment where teachers and students received the student reference.
- **X<sub>2</sub>** treatment where teachers only received the student reference.
- **X<sub>3</sub>** treatment where neither teachers nor students received the student reference (the control group).
- **O<sub>1</sub> O<sub>3</sub> O<sub>5</sub>** cognitive test on ladder safety; administered the first class day following completion of the safety unit.
- **O<sub>2</sub> O<sub>4</sub> O<sub>6</sub>** questionnaire forms that provided information for the remaining dependent variables in the study; administered at the end of the safety unit after the test had been completed.

The independent variable that was manipulated by the investigator was the extent to which teachers and students had access to the student reference. There were three levels of the independent variable: 1) both teachers and students received the student reference, 2) teachers only received the student reference, and 3) the control group where neither the teachers nor the students received the student reference. None of the subjects in a particular treatment level knew of the treatment received by the subjects in the other two treatment levels. Each of the three treatment
levels included ten sophomore vocational agriculture classes.

The dependent variables are represented diagrammatically by the two vertical sets of O's. The first of these sets represents a safety test (See Appendix B) that was given to the students to measure cognitive knowledge learned from information presented in the treatment. This test was given the first class day following completion of the ladder safety unit. The final vertical set of O's represents questionnaire forms (See Appendix C) that were given to teachers and students to obtain information on the following dependent variables: 1) the number of references on ladder safety that the teachers used in preparing and teaching the safety unit, 2) the amount of class time spent by teachers to complete the safety unit, 3) the amount of teacher preparation time needed before and during the safety unit, and 4) the amount of time students spent outside of class on the safety unit. Teachers and students were asked to complete the questionnaires at the end of the ladder safety unit after the test had been completed. Teachers were then asked to mail back the forms and the tests to the investigator so he could score, tabulate, and evaluate the data.

A brief discussion of how the study was conducted with the chronological order of events as they happened should provide a better understanding of the research effort. In the interest of brevity, the treatment groups will be referred to as follows: 1) the treatment group where teachers and students received the
student reference will be called the "treatment A" group, 2) the
treatment group where only the teachers received the student ref­
erence will be called the "treatment B" group, and 3) the treatment
group where neither the teachers nor the students received the stu­
dent reference will be called the "control" group.

After randomly selecting the thirty schools to participate in
the study, letters (See Appendix D) were sent to the vocational
agriculture teachers in these schools asking for their help and
cooperation. As has been mentioned previously, four of the schools
could not participate; thus, teachers in the first four alternate
schools were contacted by telephone, rather than letter, and they
agreed to participate in the study. They were given the same
information as was contained in the letter.

The teachers in the participating schools were telephoned;
and then, depending upon which treatment group they were assigned,
they were given information concerning the materials they would
receive and instructions regarding what was to be done in their
classes.

Materials were sent to the schools in two mailings. In the
first mailing, all schools received the following: 1) a list of
student objectives (See Appendix E) and 2) an assortment of ladder
safety materials (See Appendix F). Those teachers in "treatment A"
schools also received enough copies of the student reference so
that each student as well as themselves would have a copy; whereas,
the teachers in "treatment B" schools only received a single copy of the student reference for themselves. The teachers in the "control" schools did not receive a copy of the student reference.

A letter was sent with the first mailing of materials reiterating the instructions given by telephone. All schools were given the following instructions: 1) Do not emphasize to your students that they are in a study, 2) Do not visit with other teachers from surrounding schools about the study, 3) Teach the ladder safety unit by any method you desire, 4) Begin teaching the safety unit to your sophomores on May 20, 1975, and 5) Time is not a factor. In addition to these instructions, the letter (See Appendix G) to "treatment A" schools asked that each student be given a copy of the student reference, and then requested that the teacher and students use the reference; whereas, the letter (See Appendix G) to "treatment B" schools requested that the teacher only use the student reference and that the students not be allowed to use it. The letter (See Appendix G) received by the "control" schools made no mention of the student reference. The first mailing of materials was made one week before the study was to begin.

The second mailing of materials consisted of the following: 1) questionnaire form (See Appendix C), 2) tests and answer sheets (See Appendix B), 3) 3 x 5 cards for the students to complete (See Appendix C), and 4) a self-addressed, stamped envelope for returning materials to the investigator. A letter (See Appendix H) was
sent with the materials giving instructions on how to complete them. The 3 x 5 card (See Appendix C) sent to the schools in the "treatment A" group also asked the students to indicate whether they had used the student reference. For if they had not, this group would have then been the same as the "treatment B" group. The second mailing of materials was made on the day the study began. It was delayed so as to help prevent teachers from being tempted to teach toward the test, and from being intimidated by the questionnaires to plan or teach differently than normal.

All materials were returned to the investigator. The tests were scored by The Ohio State University's Office of Evaluation. All scores and other data were then tabulated and analyzed by the investigator.

Teachers were not given instructions on how to use the student reference as it was felt that such a procedure would create an unnatural situation. In the natural situation, teachers would typically order student references, and put them to use without specific instructions on how to use them.

Campbell and Stanley (p. 8) identified eight threats to the internal validity of research: history, maturation, testing, instrumentation, regression, selection, mortality, and interaction of selection and maturation, etc. A brief discussion of how these threats were controlled follows.
Due to the true experimental design of the study, all these threats to internal validity were controlled with the exception of differential mortality and intrasession history. They were controlled by giving all treatment levels the treatment simultaneously and by random assignment of experimental units to groups and random assignment of treatment-levels to the groups. The use of the true experimental design operates on the basis of equalization by randomization and that what happened in one treatment level happened in all treatment levels.

Differential mortality was not a problem because the study only lasted approximately one week, and the experimental units were intact classes rather than individual students.

Intrasession history of the groups was monitored by the use of a question on the questionnaire form. The histories experienced by the groups showed no substantial difference. Thus, it may be concluded that this was not a threat to the internal validity of the study.

Campbell and Stanley (p. 8) discussed four possible threats to the external validity of this design. The first such threat was the interaction of testing and the treatment. In essence, the question was: Can the findings of this study be generalized to populations that have not been pretested? Since this design does not involve a pretest, this threat did not exist.
Interaction of selection and treatment was the second threat to the external validity of this design. Since selection to the study was done randomly, this threat did not exist, and it was possible to generalize the results of the study to populations of sophomore vocational agriculture students in Ohio.

Reactive arrangements could have been a threat since the teachers knew they and their classes were in an experiment. The investigator tried to minimize this threat by not telling the teachers that they were in an experiment to evaluate a student reference. Instead, they were told that the study was to evaluate the effectiveness of teaching toward specific student objectives versus teaching without such objectives. The investigator also tried being as subtle as possible and told the teachers who were involved in the experiment that their names and the names of their schools would not appear in a report of the study. The use of machine-scored answer sheets could have also posed a problem; however, with the increased usage of these types of answer sheets in the schools, the investigator did not think this to be a serious threat. The study was conducted during the spring of the year when ladder use normally increases; consequently, there were no problems working the safety unit smoothly into the curriculum. Although the threat of reactive arrangements could have caused some problems in generalizing, the method in which it was handled reduced the threat to the point where it no longer was a problem.
Multiple treatment interference was not a threat to external validity because there was only one treatment involved.

In summary, the findings of this study can be generalized to sophomore students enrolled in vocational agriculture classes in Ohio.

Data and Instrumentation

In order to test hypothesis one, the use of a student reference on ladder safety in agricultural mechanics with students enrolled in the vocational agriculture curriculum will result in higher class scores on an objective test for classes where the teachers and students receive the reference as compared to classes where the teachers only receive the reference; whereas, classes where neither the teachers nor the students receive the reference will have lower class scores on an objective test than either of the other two classes, an instrument to measure cognitive development with respect to the ladder safety unit was developed. The score received on the posttest represented a measure (dependent variable) which reflected the effect of the level of the treatment (teachers and students received a copy of the student reference, teachers only received the student reference, and neither the teacher nor the student received a copy of the student reference). The posttest was used to arrive at this measure at the conclusion of the experiment.
This test was developed by the researcher using the ladder safety materials provided to the schools with the exception of the student reference being evaluated. The student reference was not used in writing the test because it was not provided to all the schools, and it was actually the outgrowth of reorganizing and re-writing of the information found in the other materials. The test was written so as to contain questions covering the student objectives that were provided to each of the schools. Once the researcher had developed the items, the test was pilot tested in three schools using their sophomore vocational agriculture classes. The results of the pilot posttest were then submitted to The Ohio State University's Office of Evaluation where an item analysis was performed. Along with the usual summary statistics, the Office of Evaluation also provided the total number of correct answers per item, the relative difficulty of each item, the correct phi coefficient for each item, the point biserial coefficient for each item, and a discrimination index for each item. The Kuder-Richardson 20 reliability coefficient was also reported for the instrument.

Content validity was the only type of validity of major concern for the posttest. An examination of the contents of the posttest showed that the test was composed of items representing a thorough sampling of material covered by the ladder safety unit.
The criteria established \textit{a priori} for indication that an item met the minimum standards of acceptability was that the corrected phi coefficient should not be below .25, that the point biserial correlation be at least .25, and that the discrimination index equal 20.0 or better. The pilot posttest was analyzed and revised to reflect the \textit{a priori} conditions for items to be accepted. A summary of the results of the item analysis of the pilot posttest appears in Table 1.

Table 1. Summary statistics, reliability coefficient, and mean item discrimination index of posttest (n = 122)

<table>
<thead>
<tr>
<th>Mean score</th>
<th>Standard error of measurement</th>
<th>K-R 20</th>
<th>Mean discrimination index</th>
</tr>
</thead>
<tbody>
<tr>
<td>29.78</td>
<td>2.87</td>
<td>0.90</td>
<td>.45</td>
</tr>
</tbody>
</table>

The mean score of 29.78 represented the average number of questions answered correctly. The maximum possible score was forty-four. Note that the K-R 20 reliability coefficient of .90 was very acceptable for short homemade tests. The Ohio State University's Office of Evaluation advised that any K-R 20 reliability coefficient in excess of .30 was acceptable for such tests.

The actual posttest used in the study was derived by strengthening weak items in the pilot posttest, discarding unacceptable items, and adding additional items. This instrument was administered in
the Spring of 1975. A summary of the results of the posttest used in the study appears in Table 2.

Table 2. Summary statistics, reliability coefficient, and mean item discrimination index of posttest used in the study (n = 427)

<table>
<thead>
<tr>
<th>Mean score</th>
<th>Standard error of measurement</th>
<th>K-R 20</th>
<th>Mean discrimination index</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.92</td>
<td>2.93</td>
<td>0.80</td>
<td>.30</td>
</tr>
</tbody>
</table>

This test had forty-four items thereby making the highest possible score forty-four. Notice that the mean score of 30.92 was slightly higher than was the case with the pilot instrument. Notice also that the mean item discrimination index was considerably lower for the posttest results in Table 2. The overall test reliability decreased on the posttest used in the study due to a decrease in the variability of the test.

Hypothesis two, class preparation time will be less for teachers in classes where the teachers and students receive a copy of the student reference on ladder safety in agricultural mechanics as compared to teachers in classes where the teachers only receive a copy of the student reference; whereas, teachers in classes where neither the teachers nor the students receive the student reference will require more preparation time than either of the other two groups of teachers, was tested by comparing the
total amount of preparation time used by the teachers. In this case, the independent variable was the level of treatment and the dependent variable used to reflect the effect of the treatment was preparation time spent before and during the ladder safety unit. Teachers were asked to indicate on the questionnaire form the amount of time, to the nearest fifteen minutes, that they used in preparation for teaching the unit. Granted, teachers may have inflated this measure, but one group should not have inflated the measure any more than another group.

Hypothesis three, class time required to teach the ladder safety unit will be less for classes where the teachers and students receive the student reference on ladder safety in agricultural mechanics as compared to classes where the teachers only receive the student reference; whereas, classes where neither the teachers nor the students receive the student reference will require more class time to teach the safety unit than either of the other two classes, was tested by comparing the total class time, including time for the test, used to complete the safety unit. Again, the independent variable was the level of treatment and the dependent variable used to reflect the effect of the treatment was the total amount of class time used to complete the ladder safety unit. Teachers were again asked to indicate, to the nearest fifteen minutes, the amount of time they had spent in teaching the safety unit. As has been previously mentioned, time inflation should not have been a problem.
Hypothesis four, the number of other ladder safety references used by teachers will be fewer in classes where the teachers and students receive the student reference on ladder safety in agricultural mechanics and in classes where the teachers only receive the student reference as compared to the number of safety references used by teachers in classes where neither the teachers nor the students receive the student reference, was tested by comparing the number of references used by the teachers in teaching the ladder safety unit. The teachers could have used any of the safety references furnished to them for the study, or any others they may have obtained. They were asked to check on the questionnaire form which of the furnished references they had used, and if they used others, they were asked to indicate which ones had been used. In checking through the records of the Ohio Curriculum Materials Service (the instructional materials service producing and distributing the student reference), it was determined that none of the control group schools had purchased any of the ladder safety student references.

Hypothesis five, student time required to complete the ladder safety unit will be less for classes where the teachers and students receive the student reference on ladder safety in agricultural mechanics as compared to classes where the teachers only receive the student reference and classes where neither the teachers nor the students receive the student reference, was tested by using
data obtained to determine the amount of time spent outside of class on the safety unit. The amount of time spent outside of the class was determined by having each student anonymously record on a 3 x 5 card, after the safety test, the amount of time he spent on the ladder safety unit.

Analysis of Data

The data for this study consisted of measures on the subjects in each treatment group. The data were then averaged to obtain a mean measure for each group, as the experimental unit in the study was an intact class. Scores and other data from these treatment groups were then collapsed and the resulting mean measures of the different treatment levels were used for statistical analysis.

The data for testing each of the hypotheses were analyzed and interpreted separately. Hypothesis one was analyzed by comparing the posttest scores of the treatment levels in a one-way analysis of variance.

The second hypothesis was tested by comparing the mean amount of preparation time in each treatment level in a one-way analysis of variance. The amount of class time used to complete the safety unit was averaged for each treatment level and used in a one-way analysis of variance in order to test the third hypothesis. Likewise, the number of safety references used by the teachers in each treatment level were averaged and the means were compared in a one-way analysis of variance. From the instrument used to obtain the
amount of time students spent outside of class on the safety unit, the fifth hypothesis was tested by calculating a mean amount of time for each treatment level and performing a one-way analysis of variance.

Summary of the Procedure

The study was conducted during the spring of 1975 to evaluate the effectiveness of a student reference on ladder safety in teaching safety in agricultural mechanics to high school sophomore students in vocational agriculture classes in Ohio. The study evaluated the effectiveness of the student reference in terms of the following dependent variables: 1) student performance on a cognitive test, 2) the number of other safety references used by the teacher, 3) the amount of preparation time used by the teacher, 4) the amount of time needed to teach the unit, and 5) the amount of time students spent outside of class on the safety unit. The only difference in the treatment received by the various schools was the extent to which teachers and students had access to the student reference. There were three levels of the independent variable as follows: 1) both teacher and student received the student reference, 2) the teacher only received the student reference, and 3) neither the teacher nor the students received the student reference.

The design used in the study was the posttest-only control group design as presented by Campbell and Stanley (p. 13). At the
completion of the safety unit, measures were collected, as described under the data and instrumentation section and were then analyzed and appropriate hypothesis tested using a one-way analysis of variance.
CHAPTER IV

FINDINGS

This chapter contains the findings of the experiment conducted during the spring of 1975. All findings which had a bearing on the specific hypothesis advanced in the study will be presented and discussed.

Each of the five research hypotheses advanced by the researcher were individually analyzed. In each case, the respective research hypothesis was stated in the form of a null hypothesis, an alpha risk of $p<.05$ was stated, the appropriate statistic was calculated, the tabled critical value (one-tail) was obtained, and the indicated decision was then made to either reject the null hypothesis and accept the research hypothesis if the significant findings supported the research hypothesis or to fail to reject the null and to reject the research hypothesis.

Scores Received on Ladder Safety Test

The first hypothesis stated was: The use of a student reference on ladder safety in agricultural mechanics with students enrolled in the vocational agriculture curriculum will result in higher class scores on an objective test for classes where the teachers and students receive the reference as compared to classes where the teachers only receive the reference; whereas, classes where neither the teachers nor the students receive the reference
will have lower class scores on an objective test than either of the other two classes.

The scores received on the posttest were analyzed using a one-way analysis of variance. As can be seen by inspecting Table 3, students from schools in treatment A scored higher than students from schools in treatment B. The students from schools in the control group scored the lowest.

Table 3. Means and standard deviations of scores received on posttest by treatment level

<table>
<thead>
<tr>
<th>Treatment level</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment A^a   (n=10)</td>
<td>31.76</td>
<td>2.10</td>
</tr>
<tr>
<td>Treatment B^b   (n=10)</td>
<td>30.44</td>
<td>3.08</td>
</tr>
<tr>
<td>Control^c       (n=10)</td>
<td>30.02</td>
<td>4.51</td>
</tr>
</tbody>
</table>

^aSchools where teachers and students received the student reference.

^bSchools where teachers only received the student reference.

^cSchools where neither teachers nor students received the student reference.

Students from schools in treatment A had a posttest mean score of 31.76 with a standard deviation of 2.10, students from schools in treatment B had a posttest mean score of 30.44 with a standard deviation of 3.08, while students from schools in the control group had a posttest mean score of 30.02 with a standard deviation of 4.51. There were forty-four questions on the posttest
and the score received represented the number of items the student answered correctly. An analysis of variance of the differences between these means yielded an $F$-value of 0.718 which did not surpass the critical value ($p<.05$) needed in order to reject the null hypothesis. The data, presented in Table 4, failed to support the research hypothesis; thus, the null hypothesis was not rejected.

### Table 4. Analysis of variance of posttest scores between treatment levels

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>S.S.</th>
<th>M.S.</th>
<th>$F$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>2</td>
<td>16.387</td>
<td>8.193</td>
<td>0.718</td>
</tr>
<tr>
<td>Within groups</td>
<td>27</td>
<td>307.934</td>
<td>11.405</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>324.321</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Class Preparation Time Used for Teaching the Safety Unit

The second research hypothesis was concerned with the amount of preparation time teachers would use in preparing for teaching the ladder safety unit. It was hypothesized that teachers from schools where the teachers and students received the student reference would spend less time in preparing for the safety unit than teachers from schools where the teachers only received the student reference. Teachers from schools where neither the teachers nor the students received the student reference were expected to spend the largest amount of time in preparing to teach the unit. The mean amount of preparation time used by the teachers in the various
treatment levels, and the standard deviation of each treatment level is presented in Table 5.

Table 5. Means and standard deviations of preparation time by treatment level

<table>
<thead>
<tr>
<th>Treatment level</th>
<th>Mean&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment A&lt;sup&gt;b&lt;/sup&gt; (n=10)</td>
<td>91.50</td>
<td>36.37</td>
</tr>
<tr>
<td>Treatment B&lt;sup&gt;c&lt;/sup&gt; (n=10)</td>
<td>87.00</td>
<td>56.92</td>
</tr>
<tr>
<td>Control&lt;sup&gt;d&lt;/sup&gt; (n=10)</td>
<td>136.50</td>
<td>120.92</td>
</tr>
</tbody>
</table>

<sup>a</sup>Mean amount of time in minutes.

<sup>b</sup>Schools where teachers and students received the student reference.

<sup>c</sup>Schools where teachers only received the student reference.

<sup>d</sup>Schools where neither teachers nor students received the student reference.

The data collected resulted in a mean preparation time of 91.50 minutes for teachers in treatment A (standard deviation = 36.37), a mean preparation time of 87.00 minutes for teachers in treatment B (standard deviation = 56.92), and a mean preparation time of 136.50 minutes for teachers in the control group (standard deviation = 136.50). The results of analyzing these means using a one-way analysis of variance are shown in Table 6. Although there appeared to be a large difference between the three treatment means, the difference only produced an F-value of 1.172 which was not larger than the critical value needed to reject the null and
consequently the results failed to support the research hypothesis
stated as: **Class preparation time will be less for teachers in
classes where the teachers and students receive a copy of the
student reference on ladder safety in agricultural mechanics as
compared to teachers in classes where the teachers only receive a
copy of the student reference; whereas, teachers in classes where
neither the teachers nor the students receive the student reference
will require more preparation time than either of the other two
groups of teachers.**

Table 6. Analysis of variance of preparation time between
treatment levels

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>S.S.</th>
<th>M.S.</th>
<th>F - value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>2</td>
<td>14985.000</td>
<td>7492.500</td>
<td>1.172</td>
</tr>
<tr>
<td>Within groups</td>
<td>27</td>
<td>172665.000</td>
<td>6395.000</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>187650.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Class Time Used to Teach the Safety Unit

The third hypothesis stated was: **Class time required to teach
the ladder safety unit will be less for classes where the teachers
and students receive the student reference on ladder safety in
agricultural mechanics as compared to classes where the teachers
only receive the student reference; whereas, classes where neither
the teachers nor the students receive the student reference will
require more class time to teach the safety unit than either of the
other two classes. Data in Table 7 show the mean amount of class time used to teach the safety unit including time for the posttest, to be 225.00 minutes for teachers in treatment A with a standard deviation of 68.56, 147.00 minutes for teachers in treatment B with a standard deviation of 83.31, and 160.50 minutes for teachers in the control group with a standard deviation of 98.25. Again, although there appeared to be a wide variation between the mean amount of class time used by the different treatment levels, a one-way analysis of variance produced an F - value of 2.448 which was smaller than that needed to reject the null, and therefore the research hypothesis was not supported. Information in Table 8 reveals the results of the one-way analysis of variance between the treatment level means for the amount of class time used to complete the ladder safety unit.

Table 7. Means and standard deviations of class time by treatment level

<table>
<thead>
<tr>
<th>Treatment level</th>
<th>Mean(^a)</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment A(^b) (n=10)</td>
<td>225.00</td>
<td>68.56</td>
</tr>
<tr>
<td>Treatment B(^c) (n=10)</td>
<td>147.00</td>
<td>83.31</td>
</tr>
<tr>
<td>Control(^d) (n=10)</td>
<td>160.50</td>
<td>98.25</td>
</tr>
</tbody>
</table>

\(^a\)Mean amount of time in minutes.

\(^b\)Schools where teachers and students received the student reference.

\(^c\)Schools where teachers only received the student reference.

\(^d\)Schools where neither teachers nor students received the student reference.
Table 8. Analysis of variance of class time between treatment levels

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>S.S.</th>
<th>M.S.</th>
<th>F - value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>2</td>
<td>34755.000</td>
<td>17377.500</td>
<td>2.448</td>
</tr>
<tr>
<td>Within groups</td>
<td>27</td>
<td>191632.500</td>
<td>7097.500</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>226387.500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of References Used to Teach the Safety Unit

It was hypothesized that teachers in schools where the teachers and students received a copy of the student reference and in schools where the teachers only received the student reference would use fewer safety references than teachers in schools where neither the teachers nor the students received the student reference.

As can be noted in Table 9, teachers in treatment levels A and B did not use fewer references than teachers in the control group. However, the analysis of this difference failed to produce an F - value large enough to support the research hypothesis.

Teachers from schools in treatment A used a mean number of references equal to 3.40 with a standard deviation of 1.71, teachers in treatment B used a mean number of references equal to 4.00 with a standard deviation of 1.70, and teachers in the control group used a mean number of references equal to 4.40 with a standard deviation of 0.84. The analysis of variance, as presented in
Table 9. Means and standard deviations of the number of references used by treatment level

<table>
<thead>
<tr>
<th>Treatment level</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment A&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.40</td>
<td>1.71</td>
</tr>
<tr>
<td>Treatment B&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.00</td>
<td>1.70</td>
</tr>
<tr>
<td>Control&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.40</td>
<td>0.84</td>
</tr>
</tbody>
</table>

<sup>a</sup>Schools where teachers and students received the student reference.

<sup>b</sup>Schools where teachers only received the student reference.

<sup>c</sup>Schools where neither teachers nor students received the student reference.

Table 10, of the differences between these means yielded an F-value of 1.163 which did not surpass the critical value (p< .05) needed in order to reject the null hypothesis. Thus, the research hypothesis, The number of other ladder safety references used by teachers will be fewer in classes where the teachers and students receive the student reference on ladder safety in agricultural mechanics and in classes where the teachers only receive the student reference as compared to the number of safety references used by teachers in classes where neither the teachers nor the students receive the student reference, was rejected.
Table 10. Analysis of variances of the number of references used between treatment levels

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>S.S.</th>
<th>M.S.</th>
<th>F - value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>2</td>
<td>5.067</td>
<td>2.533</td>
<td>1.163</td>
</tr>
<tr>
<td>Within groups</td>
<td>27</td>
<td>58.800</td>
<td>2.179</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>63.867</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Student Time Spent Outside of Class on the Safety Unit

The fifth research hypothesis was concerned with the amount of time students spent outside of the classroom studying the safety unit. It was hypothesized that: Student time required to complete the ladder safety unit will be less for classes where the teachers and students receive the student reference on ladder safety in agricultural mechanics as compared to classes where the teachers only receive the student reference and classes where neither the teachers nor the students receive the student reference. The students in each treatment level recorded, at the completion of the safety unit, the amount of time, in minutes, they devoted to the ladder safety unit outside of class on 3 x 5 index cards. These data were averaged to yield a mean number of minutes for each treatment level. Presented in Table 11 is the mean amount of time students spent outside of class studying on the safety unit, and the standard deviation of each treatment level.
Table 11. Means and standard deviations of time spent outside of class by treatment level

<table>
<thead>
<tr>
<th>Treatment level</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment $A^b$ (n=10)</td>
<td>13.82</td>
<td>12.34</td>
</tr>
<tr>
<td>Treatment $B^c$ (n=10)</td>
<td>14.77</td>
<td>15.37</td>
</tr>
<tr>
<td>Control $d$ (n=10)</td>
<td>34.91</td>
<td>31.66</td>
</tr>
</tbody>
</table>

$^a$Mean amount of time in minutes.

$^b$Schools where teachers and students received the student reference.

$^c$Schools where teachers only received the student reference.

$^d$Schools where neither teachers nor students received the student reference.

The data collected showed the mean amount of time spent outside the class to have been 13.82 minutes for students in treatment A with a standard deviation of 12.34, the mean amount of time spent outside the class was 14.77 minutes for students in treatment B with a standard deviation of 15.37, and the mean amount of time spent outside the class was 34.91 minutes for students in the control group with a standard deviation of 31.66. Information in Table 12 reveals the results of analyzing these means by using a one-way analysis of variance. Again, although there appeared to be a large enough difference between these treatment means to be significant, the difference only produced an $F$-value of 3.061 which was not larger than the critical value needed to reject the null and consequently the results failed to support the research hypothesis.
Table 12. Analysis of variance of time spent outside of class between treatment levels

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>S.S.</th>
<th>M.S.</th>
<th>F-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>2</td>
<td>2838.125</td>
<td>1419.063</td>
<td>3.061</td>
</tr>
<tr>
<td>Within groups</td>
<td>27</td>
<td>12515.680</td>
<td>463.544</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>15353.805</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The analysis of data pertaining to each of the five research hypotheses revealed that none of the hypotheses were supported. In each case, there was no significant difference in the measures analyzed for each of the research hypotheses.
CHAPTER V

DISCUSSION

In hypothesis one, student score on a posttest was the dependent variable being evaluated. Students in treatment A (the group where teachers and students received the student reference) received higher test scores than did students in treatment B (the group where the teachers only received the student reference). Students in the control group (the group where neither the teachers nor the students received the student reference) scored lower than the other two groups and had the largest amount of variability in their test scores. Although the data revealed a difference in the test scores between the three treatment groups, the difference was so slight that it was not significant. Such a difference could have occurred by chance; thus, one cannot contribute the difference in student test scores as being due to the availability of the student reference on ladder safety.

The amount of time teachers spent in preparing to teach the unit on ladder safety was the variable being studied in hypothesis two. Teachers in the control group spent the largest amount of time preparing to teach the ladder safety unit whereas teachers in treatment B (the group where only the teachers received the student reference) spent the least amount of time preparing to teach the safety unit. The author hypothesized that teachers in schools where the teachers and students received the student reference
treatment A) would utilize more supervised study with the student reference and, thus, would reduce the amount of preparation time needed to prepare for the unit as compared to teachers in schools where the teachers only received the student reference; this was not the case. It was further hypothesized that the teachers in the control group would use the largest amount of preparation time because they would need to consult many different references in order to obtain the information needed to teach the safety unit. The control group varied considerably on this variable. Although the teachers in the control group did use considerably more preparation time than did the teachers in treatments A and B, the difference was not large enough to be significant. Thus, one cannot say that the student reference on ladder safety reduced the amount of preparation time teachers needed to prepare for teaching the unit.

Hypothesis three was concerned with the amount of class time used in teaching the ladder safety unit. It was hypothesized that the least amount of time would be used by the group receiving enough student references so that the teachers as well as all students would have a copy. It was believed that the information contained within the student reference was presented in such a manner as to make for easy, fast comprehension by the students, thus reducing the amount of time the teacher would need explaining the material. It was further hypothesized that teachers in the control group would use the largest amount of time in teaching the
safety unit because all teaching would have to be done without the benefit of a highly illustrated student reference aiding in the clarification of certain points and procedures. The data did not support the hypothesis. In fact, the results of the study indicated almost the opposite to be true. Teachers in treatment B (the group where only the teachers received the student reference) spent the least amount of class time teaching the unit followed closely by teachers in the control group. Teachers in treatment A (the group where both the teachers and students received the student reference) spent the largest amount of class time teaching the ladder safety unit. The investigator believes this phenomenon may be explained by the fact that the student reference contained a vast amount of information and was very well illustrated. The students may have spent much more time than was necessary to accomplish the stated objectives in reading about ladder use and safety and in looking at the pictures and illustrations. The use of the highly illustrated student reference may have served to increase student motivation thus actually causing an increase in the amount of class time needed to cover the unit. Although the data revealed an almost opposite situation to exist than was hypothesized, the difference was not large enough to be significant. Thus, one may conclude that the availability of the student reference did not decrease the amount of time needed to teach the ladder safety unit.
The number of ladder safety references used by the teacher in teaching the ladder safety unit was the fourth variable evaluated. It was hypothesized that teachers receiving a copy of the student reference on ladder safety would use fewer other references on ladder safety as compared to teachers in the control group because the student reference was actually a composite of the information contained in the other references. The data revealed this hypothesis to be true; however, the difference was so slight that it was not significant. It is the author's belief that this research hypothesis was not supported because all teachers received the same references with the exception of the student reference on ladder safety; and consequently, because they were available, teachers used them for fear of not completely presenting all available information. Regardless, one has to conclude that the availability of the student reference on ladder safety did not appreciably reduce the number of ladder safety references that a teacher would use in teaching the unit.

The fifth variable evaluated was the amount of time outside of class the students spent studying the ladder safety unit. It was hypothesized that students having a copy of the student reference on ladder safety would spend less outside time studying the unit than students not having access to the student reference. The author believed that more time would have been spent in supervised study with students having a copy of the student reference whereas
students without a copy of the student reference would have had less time devoted to supervised study, thus, causing them to depend more on outside time for their studying. The data supported this belief; however, the difference was not great enough to be significant. The variability in the amount of time students spent outside of class studying the unit was large among all groups. This tended to suggest that the amount of time spent outside of class studying the safety unit to be an individual student choice rather than a function of the availability of the student reference. One would conclude that the availability of the student reference did not affect the amount of outside time the student would spend studying ladder safety.

In summary, an analysis of the dependent variables used in this study to evaluate the effectiveness of a student reference on ladder safety did not support the student reference as being any more effective than others that were available. Evidently, the student reference in itself was not a powerful enough variable to effect supremacy. However, it should also be stated that the student reference on ladder safety did not decrease student performance or teacher effectiveness; thus, it can be considered to be as good a reference as other available references.
CHAPTER VI

SUMMARY

The major purpose of this study was to evaluate the effectiveness of a student reference in teaching ladder safety in agricultural mechanics to high school sophomore students enrolled in vocational agriculture classes in Southwestern Ohio. More specifically, the study evaluated the effectiveness of the student reference in terms of the following dependent variables: 1) student performance on a cognitive test, 2) the number of other safety references used by the teacher, 3) the amount of preparation time used by the teacher, 4) the amount of time needed to teach the safety unit, and 5) the amount of time students spent outside of class on the ladder safety unit. The independent variable that was manipulated in the study was the extent to which teachers and students had access to the student reference. There were three levels of the independent variable as follows: 1) both teachers and students received the student reference, 2) the teachers only received the student reference, and 3) neither the teachers nor the students received the student reference. The study was designed to test the following research hypotheses:

1. The use of a student reference on ladder safety in agricultural mechanics with students enrolled in the vocational agriculture curriculum will result in higher class scores on an objective test for classes where the teachers and students receive the reference as compared to classes where the teachers only receive the reference; whereas, classes where neither the
teachers nor the students receive the reference will have lower class scores on an objective test than either of the other two classes.

2. Class preparation time will be less for teachers in classes where the teachers and students receive a copy of the student reference on ladder safety in agricultural mechanics as compared to teachers in classes where the teachers only receive a copy of the student reference; whereas, teachers in classes where neither the teachers nor the students receive the student reference will require more preparation time than either of the other two groups of teachers.

3. Class time required to teach the ladder safety unit will be less for classes where the teachers and students receive the student reference on ladder safety in agricultural mechanics as compared to classes where the teachers only receive the student reference; whereas, classes where neither the teachers nor students receive the student reference will require more class time to teach the safety unit than either of the other two classes.

4. The number of other ladder safety references used by teachers will be fewer in classes where the teachers and students receive the student reference on ladder safety in agricultural mechanics and in classes where the teachers only receive the student reference as compared to the number of safety references used by teachers in classes where neither the teachers nor the students receive the student reference.

5. Student time required to complete the ladder safety unit will be less for classes where the teachers and students receive the student reference on ladder safety in agricultural mechanics as compared to classes where the teachers only receive the student reference and classes where neither the teachers nor the students receive the student reference.

High school classes of sophomore vocational agriculture students were used in the study. The classes were randomly selected and were then randomly assigned to one of three experimental groups. The treatment levels (student reference to teachers and students, student reference to teachers only, and the control group where neither the teachers nor the students received the student
reference) were then randomly assigned to the three experimental groups.

The design used in the study was the posttest-only control group design. The data collected on the subjects in each treatment group were averaged to obtain a mean measure for each group. The scores and other data from these treatment groups were then collapsed and the resulting mean measures of the different treatment levels were used for statistical analysis using a one-way analysis of variance.

The results of the study indicated that regardless of the treatment level, students performed about the same on a cognitive posttest on ladder safety with means of 31.76, 30.44, and 30.02 for treatment A, B, and control groups respectively. Differences were not found to be significant.

Teachers spent an average of 91.50 minutes in preparing to teach the ladder safety unit in treatment A, 87.00 minutes in treatment B, and 136.50 minutes in the control group. Although there was a wide variation in the amount of preparation time used by the teachers in the three treatment groups, it was not significant.

The mean amount of class time that teachers devoted to teaching the ladder safety unit was 225.00 minutes for treatment A, 147.00 minutes for treatment B, and 160.50 minutes for the control group. These times were not significantly different.
The number of safety references used by the teachers in preparing for and teaching the safety unit did not differ significantly between the three treatment groups. Teachers used an average of 3.40 references in treatment A, 4.00 references in treatment B, and 4.40 references in the control group.

Students spent an average of 13.82 minutes outside of class studying on the ladder safety unit in treatment A, 14.77 minutes in treatment B, and 34.91 minutes in the control group. These times were not significantly different.

In summary, the results of the analysis of all hypotheses indicated that none of the research hypotheses were supported.

Brown (1969, pp. 242-243) best summarized the results when he said:

Instructional materials are evidently not powerful enough in themselves to produce a statistically detectable change in learning.

He goes on to say:

...although field experiments are the appropriate testing ground, researchers probably should not have expected to detect measurable differences in student learning without a more powerful experimental variable.
CHAPTER VII

RECOMMENDATIONS

Based on the results of this study, the researcher makes the following recommendations for further related research:

1. Similar studies should be conducted utilizing other subject matter student references that would include a manipulative test in addition to a cognitive test.

2. Other dependent variables such as student and teacher attitudes toward the student reference should be utilized in addition to those evaluated in this study.

3. Instead of providing the schools with a number of different references on the subject of ladder safety, it might be more realistic to provide each school with a list of the references available for teaching the unit and then have the teachers choose the reference/s that they want to use. They could then purchase these references prior to the beginning of the study. Such a method could provide for the evaluation of various references in the same study.

4. The inclusion of the independent variable "method of teaching" in the study could provide some information relative to the best method to use when utilizing student references.
5. Instruction in the use of student references might be an independent variable that could be included in the study so as to provide information relative to the in-service education needs of teachers, or the types and necessity of instructions to accompany student references regarding their use.
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To my sisters Janette and Jean for their support and encouragement during this writer's graduate program.
APPENDIX A: STUDENT REFERENCE ON LADDER SAFETY
UPS AND DOWNS
THE BASIC PRINCIPLES OF LADDER SAFETY

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FOREWORD

The student reference entitled Ups and Downs - The Basic Principles of Ladder Safety has been designed for high school students in vocational agriculture enrolled in the agri-business curriculum. Many of the jobs held by students will require the use of some type of ladder. This reference has been developed to help the student select and use a ladder safely to prevent injury.

While this reference will help the teacher in planning his instructional unit, it is recommended that for maximum benefit each student have a copy of Ups and Downs - The Basic Principles of Ladder Safety. The safety test developed for this unit can be administered to the student and then kept on file by the teacher as evidence that the student has satisfactorily completed the unit. For a more detailed discussion on the topic of ladder safety, it is recommended that the following reference be made available to the student: Federal Register, Occupational Safety and Health Administration, Department of Labor, Washington, D. C., Part II, Volume 36, Number 105, May 29, 1971.

The author of this reference received his B. S. degree from Iowa State University in agricultural education. He taught vocational agriculture for five years at Charles City High School, Charles City Iowa. This student reference was prepared while the author was a Curriculum Materials Associate at The Ohio State University working with the Ohio Agricultural Education Curriculum Materials Service.

James E. Dougan, Director
Agricultural Education Service
State Department of Education

Harlan E. Ridenour, Director
Ohio Agricultural Education
Curriculum Materials Service
UPS AND DOWNS - THE BASIC PRINCIPLES OF LADDER SAFETY

Why study ladder safety? You, no doubt, know all about a ladder. You know what a ladder is and have probably used one. The ladder is a simple widely used tool but, as with everything else if it is used improperly it can cause you trouble.

How many times have you seen a news article like this in your newspaper?

Painters Break Neck in Tumble From Ladder

A near North Side painter died Monday after he fell from a ladder while painting trim around second-floor windows of a house.

Charles HB, 39, of 158 Benevolent Ave, died in Humboldt Hospital at 4:45 p.m. A hospital spokesman said he apparently died of a broken neck. A coroner’s ruling is expected.

Fire department emergency squadman said he was painting the Harry W. residence at Benevolent Ave., when he fell from an 18-foot ladder about 3:23 p.m. They said he struck another ladder on the way down and landed head first on a jagged rock at the bottom of the ladder.

Ask yourself, does knowing what a ladder is and having probably used one mean there is nothing more to learn? Do you know the many types of ladders and how to select the proper one for your job? How to care for a ladder and to use it safely? Also, do you know what situations can lead to ladder accidents or the types of injuries that can result because of these accidents?

An analysis of 150 accidents involving ladders in construction work revealed that the four principal causes of ladder accidents are (1) climbing or descending improperly, (2) failure to secure ladder at top and/or bottom, (3) structural failure of the ladder itself, (4) carrying objects in hands while climbing or descending.

Ladders, being simple widely used tools, can cause a false sense of security to the user, thus the reason for developing this unit. The information provided should enable you to use a ladder safely to prevent possible injury to yourself or other people and to avert property damage. Remember, the law of gravity hasn’t been repealed.

You should be able to do the following after completing this unit:

1. Select the appropriate type ladder for a particular job
2. Determine if each part of the ladder is sound and functioning properly
3. Use a ladder so as to prevent injury to yourself, other people, or property
4. Maintain and repair the ladder to prevent ladder failure
5. Store a ladder to prevent deterioration
6. Identify situations that could result in ladder failure or accidents
7. Transport the ladder to prevent damage or accident to the ladder, the user, other people, or property
Before using a ladder, you should become familiar with its different parts and their functions. As you study the following definitions and illustrations, you will see that the parts on different types of ladders are quite similar in nature. See Figures 1, 2, and 3.

**Parts of the Ladder**

1. **Backlegs:** The legs on the back of a self-supporting ladder that give it stability and aid in its ability to carry a load.
2. **Braces:** Devices that give additional support to the ladder to insure greater safety to the user.
3. **Fly:** A section of an extension ladder which may be elevated by extending it out of the main section. There may be more than one fly section in one ladder.
4. **Guides:** Wood or metal strips on an extension ladder which guide the fly section while it is being elevated.
5. **Halyard:** The rope or cable used to elevate the fly sections of an extension ladder. Not all extension ladders are so equipped.
6. **Heel:** The end of the ladder which rests on the ground.
7. **Locks:** Devices which hold and lock the fly section in position when it is extended. Also called pawls or dogs.
8. **Main Section:** The bottom (bed) section of an extension ladder.
9. **Pulley:** A small grooved wheel used to guide the halyard.
10. **Rungs:** Crosspieces between the side rails, by means of which the ladder is climbed. Also called steps or cleats.
11. **Safety feet:** Devices that help prevent the heel of the ladder from slipping.
12. **Shelf:** A device intended to support tools while working.
13. **Side Rails:** The side pieces of a ladder which support the rungs and which may be either solid or trussed. Also called the beam.
14. **Spreader:** A mechanical device found on self-supporting ladders to keep the backlegs in the correct open position for maximum stability and safety.
15. **Stops:** Limiting devices which prevent the fly section from being overextended when elevated, or retracted beyond its proper position when nested into the main section.
16. **Tie-rods:** Small diameter steel rods beneath the rungs that help prevent spreading of the side rails. These rods also serve the additional function of absorbing the shock and strain of an individual should the rung or step break.
17. **Tip:** The upper end of the ladder as opposed to the heel.
18. **Top brace:** Serves to secure the top, side rails, and backlegs together into one unit.
Figure 1. Extension Ladder.

Figure 2. Type I, Step Ladder.

Figure 3. Enlarged Section of an Extension Ladder.
LADDER TYPES

Ladders come in many different types, and are made of many types of material. Regardless of type or material used in construction of the ladder, it should conform to the safety standards of the American National Standards Institute (ANSI), and be approved by the American Ladder Institute. An example of this seal of approval is shown in Figure 4.

Some of the more common types of ladders are shown in this publication. These are by no means all the types available, but represents the major types you are most likely to come into contact with on the job.

Step Ladder: A general purpose, self-supporting portable ladder manufactured in three types, depending upon the use the ladder is expected to receive. Step ladder use should be limited to firm, level footing. Step ladders are normally made of wood or metal, and are designed to carry only one person. The three types of step ladders are:

Type I: Industrial step ladder, 3 to 20 feet in length, designed for heavy duty use, such as utilities, contractors, and industrial use.

Type II: Commercial step ladder, 3 to 12 feet in length, designed for medium duty use, such as painters, offices, and light industrial use.

Type III: Household step ladder, 3 to 6 feet in length, designed for light duty, such as light household use.

The three types differ in the size of the structural members used and in the amount and type of bracing. The bracing should not be used for climbing. Figure 5.
**Single Portable (Straight) Ladder:** A general purpose ladder manufactured in one section that cannot be over 30 feet in length. It is normally made of wood or metal, and is designed to carry only one person. (See Figure 6.)

**Extension Ladder:** A general purpose portable ladder that may be raised or lowered to provide different lengths. Normally manufactured in two sections if of wood and may be in three sections if of metal. It cannot be over 60 feet in length. Stops should be installed to insure the required overlap of the sections. The minimum overlap up to and including 36 feet is 3 feet, over 36 feet up to and including 48 feet is 4 feet and over 48 feet up to and including 60 feet is 5 feet. The extension ladder is designed to carry only one person. All extension ladders should consist of sections, one to fit within the side rails of the other, and arranged in such a manner that the upper section can be raised and lowered. All moving parts shall be such that they operate freely and securely without binding or unnecessary play. (See Figure 7.)

![Figure 6. Single Portable (Straight) Ladder.](image1)

![Figure 7. Extension Ladders.](image2)
Cherry (Spike) Ladder: A portable ladder for use in orchards. The converging side rails are designed for placement in a limb crotch. Stability is given to the ladder by its virtual one-point top bearing contact and its double base which retards excessive, uneven ground penetration. The ladder is designed to carry only one person. It may be obtained in lengths up to 30 feet for single section ladders and up to 60 feet for extension spike ladders. The ladder may be of either wood or metal construction. Rubber sleeves, which may be obtained for the upper rail sections, reduce branch abrasion and the possibility of slipping along the limb. (See Figure 8.)

Tripod Orchard Ladder: Not a general purpose ladder and should be restricted to pruning and harvest operations in the orchard. Because of the single back leg and flared side rails this ladder provides relatively stable support on soft, uneven ground. The ladder has no spreaders, locking devices, safety shoes, etc. As it is intended for use only in restricted areas. The ladder is normally constructed of wood or metal, and can be obtained in lengths up to 16 feet. Figure 9. It is designed to carry only one person. A double-base tripod orchard ladder may be obtained for those wishing added stability.

Trestle Ladder: A ladder designed to be used in pairs to support planks or staging. The individual then works from the planks rather than the rungs of the ladder. The rungs are normally spaced 12 inches apart, and are staggered on the opposite side rails to provide 6 inch intervals for planks or staging. The ladder is designed to carry only one person, and may be obtained in lengths up to 20 feet. Figure 10.
Extension Trestle Ladder: Like the trestle ladder, is designed to be used in pairs to support planks or staging. This ladder offers greater flexibility as the extension section is adjustable to the height desired. The base section of an extension trestle ladder can be obtained in lengths up to 20 feet. As can the extension section of the ladder. The lap of the extension section into the base should never be less than 3 feet. The ladder is designed to carry only one person. Figure 11.

There are many special purpose ladders not included in this publication. Some of the special purpose ladders are: platform, painter's step ladder, mason, trolley, side-rolling, sectional, pompier, roof, manhole, etc. A real reason exists for such a variety of ladders. In short, selecting the proper tool for the best job performance is an important part of ladder safety.

The ladders discussed in this publication should not be used by more than one man at a time. When ladder jacks and scaffold planks are used, one person is still the limit on loading of the ladders. Where more than one person is to be on a ladder at the same time, specially manufactured ladders with larger structural members and more bracing should be used.

The principles covered in this publication, with some modification, will apply to the special purpose ladders as well as to those ladders illustrated.

LADDER USE

When using a ladder, you are normally off the ground and subject to falls. This makes it important for you to practice accepted methods of ladder use to prevent possible accidents and such accidents can range from bruises or minor sprains to death, thus correct ladder usage is essential.

The following ladder uses practices should help you in preventing accidents while working with a ladder.

1. Ladder inspection

Before using any ladder, you should check it for possible defects. Figure 12. Some of the defects that can be observed by a quick visual inspection include:

a. Loose steps or rungs (considered loose if they can be moved at all with the hand)
b. Loose nails, screws, bolts, or other metal parts
c. Cracked, split, or broken side rails, braces, steps, or rungs
d. Slivers on side rails, rungs, or steps

Figure 12. Visually inspecting a ladder.
e. Damaged or worn safety shoes
f. Wobbly
g. Loose, bent, or broken spreaders
h. Loose hinges
i. Loose, broken, or missing locks
j. Defective locks that do not seat properly
k. Defective rope

Ladders found defective in any way should be marked and not used until repaired. Ladders that are beyond repair should be destroyed.

Companies that use ladders in their work should provide for detailed inspections at regular intervals. The frequency of the inspections will depend upon the kind of work and the amount of use the ladders receive. When a ladder has been dropped it should be inspected before being used. All such inspections must be performed by a person qualified to inspect ladders.

2. Positioning the ladder

It is important to position the ladder against the building or other object being climbed to obtain a slope or angle so that it is stable when your weight is on the ladder. Some of the recommended practices are as follows:

a. The heel of the ladder should be moved far enough away from the object being climbed to provide stability when you have your weight on the ladder. If the heel is too close, the ladder will be too steep and you may fall backward or sideways. If the heel is too far away, the heel will tend to slip back causing you to fall. Also, if the ladder is too flat in position, it may break under your weight.

THUMB RULE: The following thumb rule may help you: Place the heel of the ladder out from the object being climbed, a distance equal to one-fourth the distance from the heel to the point where the top is being supported. Figure 13.

A simple practice to use in determining a safe ladder slope or angle is shown in Figure 14, on the following page. Take a position with your toes against the ladder side rails, while standing erect with your arms extended straight forward. If the ladder slope is correct your hands will fall on the rung in a grasping position. If only your fingertips touch the rung, the heel is too far out. If the heel of your hand touches the rung, the heel of the ladder is too close.

Figure 13. Correct ladder position using the thumb rule.
b. When standing behind the ladder the top should appear directly above the heel as in Figure 15. If the top is to the right or left of the heel, there is danger of slipping sideways when your weight is added to the ladder.

c. Always place the heel of the ladder on a firm surface. You can check the firmness of the surface by putting your weight on the first rung, first on one side, then the other. Figure 16. This will show you if the side rails will sink in or slip. If the ground is soft, sinking may be prevented by using a large flat piece of wood under the heel as shown in Figure 17.
If the ground surface is uneven, one of the side rails may be supported on blocks of wood large enough to be stable. Figure 18.

Figure 18. Supporting a ladder side rail on uneven ground.

d. When the ladder tip falls at a window a board can be securely attached across the back of the ladder. Figure 19. The board extends across the window to provide a firm support against the window frame or building wall.

e. If the ladder is placed before a door that opens toward the ladder, the door should be locked, blocked open, or guarded.

f. When it is not possible to place the ladder in a stable position, it should be securely tied or held to prevent shifting and falling. When using a ladder on high pitched roofs, added stability and safety may be obtained by using hooks on the tip of the ladder as shown in Figure 20.

g. The top rest for the ladder should be rigid and strong enough to support the load when you climb the ladder.

h. Ladders should only be used for their intended purpose. They never should be used as a guy, brace, or skid.
i. When access to a top landing or roof is necessary, the ladder should extend at least three feet above the top support. This provides you with something to hold onto as you climb onto a roof or landing. Figure 21.

j. For any given job you will need to determine the length of ladder needed. You will know the vertical height to be climbed. However, when the heel of the ladder is moved out from the base to provide stability to the ladder a greater length is required.

THUMB RULE: A rule of thumb for determining minimum ladder length for a given job, the ladder should be approximately one foot longer than the vertical height. This does not give an exact figure. As the vertical height increases above approximately 30 feet, more than one foot will need to be added. When the vertical height decreases below approximately 30 feet, less than one foot will need to be added. You must remember that when extension ladders are used, you have to provide for the minimum overlap when determining ladder length. For example, assume a vertical height of 30 feet. Using our rule of thumb, the approximate minimum ladder length would be 31 feet. To allow for the minimum overlap of three feet for the extension ladder, you would need a 34 foot extension ladder. Figure 22.

If the ladder is to extend above the point of support to provide access to a landing area or roof this distance should also be added to the ladder length. (Section i) Figure 23.
For example, you would need at least a 37 foot extension ladder (34 foot extension ladder to reach the top support, plus an additional three feet for access to the roof, gives you 37 feet). Since ladders are normally sold in only even feet (34 ft., 36 ft., 38 ft., etc.) you would have to use a 38 foot ladder.

3. Raising and adjusting extension ladders

Height adjustment of extension ladders should only be made while standing at the base with the ladder in the vertical position. This will allow you to observe when the locks are properly engaged. Height adjustments should never be made with someone on the ladder. To raise the extension ladder to the vertical position, brace the heel of the ladder so it cannot slide. Then grasp the rung at the tip, raise the tip, and walk forward under the ladder moving your hands to grasp other rungs as you proceed. Figure 24. Once the vertical position has been reached, the fly section is raised or lowered to the desired length. Watch where you place your fingers, so they will not be crushed. Figure 25. Once the desired length is obtained, the ladder heel should be moved until the ladder rests in the correct position for climbing. The extension ladder must be positioned so the fly section is resting on top of the main section. With large, heavy extension ladders, you should obtain help when adjusting them.

4. Checking your shoes

Before climbing the ladder, you should check your shoes to see that they are clean to prevent possible slipping on the rungs. Figure 26.
5. Use of ladder safety shoes

All portable rung ladders should be equipped with safety shoes suitable for the floor or ground it stands on. Figure 27. Safety shoes are not intended as a substitute for care in placing a ladder that is being used on slippery surfaces. If the surface is very slippery, tie the ladder at the base or have someone hold it. Middle and top sections of sectional ladders should not be used as bottom sections unless they are equipped with safety shoes.

6. Climbing the ladder

When climbing up or down, you should always face the ladder and hold on with both hands. Ladder climbing should be done smoothly in order to reduce bouncing and swaying. Two methods of climbing are practiced. These are the hands on side rail method, Figure 28, and the hands on rung method, Figure 29. Regardless of the method used, you should grasp the side rails or rungs firmly so that if a rung under foot should break, you could prevent a fall by holding on to the ladder. Avoid sliding your hands up and down the side rails when climbing or descending.
In climbing, your feet should be placed near the center of the rung. In climbing up, your weight rests on one foot as the other foot is being placed on the next higher rung. Your weight is then transferred to the foot on the higher rung. You will continue in this manner without skipping rungs until you reach the desired height. In climbing down, the reverse procedure is followed with your weight being transferred from a higher rung to a lower rung without skipping rungs until the desired level is reached. Regardless of whether you are climbing up or down, the body is kept erect and the arms are straight. Your eyes should be looking slightly upward while climbing up and slightly downward while climbing down.

7. You should climb no higher than the third rung from the top of a ladder so that a hand hold will always be available. Figure 30. By working too high on a ladder, there is always the chance of losing your balance and falling. On step ladders, you should select a ladder high enough to permit you to stand at least two steps from the top when working. In addition to the possibility of losing your balance, the top of an ordinary step ladder should not be used as a step, as its major purpose is to tie the side rails and back legs together and not to support your weight.

8. Working positions on the ladder

It is important that you keep yourself in a stable position while working from a ladder. Some precautions to follow are listed:

a. The ladder should be set where your work can be easily reached. Figure 31. You should never lean out too far to one side. This distributes your weight unevenly as the ladder and it could fall or tip over. It is better to move the ladder to your work than to risk an accident.

Figure 30. Staying at least three rungs down from the top of the ladder so a hand hold is always available.

Figure 31. Placing the ladder so work is within easy reach.
b. You should work facing the ladder and hold on with one hand.

c. Avoid working from ladders in high winds.

d. Avoid trying to straddle the space between the ladder and building or other object being climbed.

e. When it is necessary to work with both hands, you should use a leg-lock for security. Two positions are recommended. One allows you to face the ladder; the other to face away from the ladder.

Leg-lock facing the ladder: Figure 32. After reaching the desired height, pass one leg through the ladder, over the second rung above the one on which you are standing. Then bring your foot back through the ladder with your leg over the second rung above the one you are standing on and hook your foot around the side rail. Once your foot is hooked, step down one rung with your other foot. The leg-lock should be made opposite to the side on which work is being done.

Leg-lock facing away from the ladder: Figure 33. After reaching the desired height, place your leg through the ladder over the second rung above the rung on which you are standing. Then bring your foot back through the ladder with your leg over the second rung above the one you are standing on and hook your foot over the side rail. After hooking your foot, step down one rung with your other foot as you turn it to face away from the ladder. Care must be exercised when getting into these leg-locks to prevent the possibility of falling. When using these methods, the top of the ladder should be secured so that a pulling or pushing action will not move the ladder from its correct position.
9. Hoisting tools

Tools that cannot fit in suitable pockets should be hoisted with a rope. Figure 34. You should never carry heavy or bulky materials or tools when climbing a ladder. These objects could fall and injure someone below or cause you to lose your hold on the ladder and fall.

10. Avoiding electrical shock

Metal ladders should not be used near electrical conductors because of the possibility of electrical shock. Never work on or around electrical lines without proper training and equipment.

11. Positioning step ladders

When using a step ladder, you should make sure it is fully spread with the spreaders locked in the open position. Figure 35. All four legs should be on a firm surface. On uneven surfaces, the leg(s) can be supported by a piece of wood. Figure 36. The wood piece should be of such dimensions to provide stability and support to the ladder and its load. A step ladder should not be used in the closed position against a wall like a portable rung ladder.

Figure 34. Hoisting tools with a rope and bucket.

Figure 35. Step ladder which is fully spread with the spreader locked.

Figure 36. Supporting a step ladder leg on uneven ground.
12. Using reinforced ladders

Portable rung ladders with reinforced side rails should be used with the metal reinforcement on the underside. Such a practice allows the greatest strength and safety to the user.

13. Do not improvise

You should not splice short ladder sections together to make longer sections nor should you use ladders that are made by fastening cleats across a single rail. Improvised repairs or modifications should not be used on ladders.

14. Handling ladders

Proper handling prevents damage to ladders and injury to yourself, other people or property. Because of the weight and leverage involved when handling ladders, you should form the habit of lifting with your legs and keeping your back straight. Figure 37. The same procedure should be followed when putting the ladder down. You should obtain help when handling large, heavy ladders.

Ladders should be carried over your shoulder with the tip slightly elevated to permit you to see obstacles in your path. Figure 38. It also allows persons coming around corners to see the ladder. The ladder should be balanced with an equal amount of weight both to the front and to the rear. The arm of your supporting shoulder should help carry the weight. The other hand should grasp the rung ahead of the balance point to add stability.
Do not drop the ladder as the impact weakens the structure. Also, avoid handling ladders in high winds.

15. Do not leave ladders unattended

You should never leave a ladder where it could fall, be tipped over, or children could climb it. When finished using a ladder, put it back in its correct storage location.

LADDER STORAGE AND MAINTENANCE

To insure yourself of accessibility, convenience, safety, and serviceability of a ladder when needed, the following practices should be observed:

1. Ladder storage areas should be located where the ladders may be obtained with speed and ease should an emergency arise. In addition to storage location, the type of storage should prevent possible accidents when removing or replacing ladders. Three types of ladder storage are shown. Figures 39, 40, 41. Ladders stored in a horizontal position need support at several points to prevent sag.

2. Storage areas should protect the ladders from the weather, but they should receive good ventilation. Wood requires a certain amount of moisture (10-15%) for strength. Excessive amounts of moisture or lack of it reduces the strength of wood. You should avoid hot, dry storage areas where the wood might lose moisture and damp areas where the wood might pick up moisture. The storage area requires good ventilation to prevent the wood from getting dry rot and/or fungus growth. Metal ladders are not affected by storage conditions like wood ladders.

3. Wood ladders should be coated with a protective material (varnish or shellac) to help the wood remain at the desired moisture content. Paint can be used, but is not recommended because it could conceal cracks.

4. You should maintain the ladder in such a condition that its ready for use whenever needed. All joints should fit tightly together, all hardware should be securely attached, and all movable parts should operate freely without binding or unnecessary free play. Halyards, safety feet, locks, pullies, etc. should be kept in good condition so they will operate correctly without failure. Movable parts should be lubricated as necessary so they will operate without binding. Ladder inspection (mentioned earlier in the publication) is an important part of ladder maintenance.

5. On wood ladders with tie-rods, the joint between the rungs and side rails may be tightened if they become loose. Hold the tie-rod under the rung or step with a pair of pliers and tighten the nut on the outside of the side rail with a wrench. Figure 42. Be careful not to overtighten because if the wood absorbs moisture and swells, the nuts could cut into the side rails and damage them. This same practice applies when tightening other parts that may become loose. Remember, don’t overtighten.
Figures 39, 40, 41. Types of ladder storage.

Figure 39.

Figure 40. Tightening a tie-rod on a step ladder.

Figure 41.

Figure 42. Tightening a tie-rod on a step ladder.
6. Ladders should be kept free of materials that could make them slippery such as oil and grease.

7. When transporting ladders on a vehicle, you should have them securely attached to prevent chafing and bouncing. They should also be supported at enough points to prevent sag. The supporting points, when transporting metal ladders, should be of a material that is softer than the ladder (wood, rubber-covered metal).

It is hoped that after finishing this unit, you are now familiar with the importance of the ladder as a working tool. The ladder, like any working tool, can be used safely or unsafely. You have the responsibility of applying the principles covered in this publication to the selection, storage, transportation, and use of ladders. Don't become an accident victim because of unsafe acts! Remember, the law of gravity hasn't been repealed. By taking the test which accompanies this publication, you will be able to check on your knowledge of ladders.
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*Ladder - Types, Use, Care*, Accident Prevention Division, Workman’s Compensation Board, Labor and Industries Building, Salem, Oregon 97310.

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Joseph A. Gliem
Curriculum Materials Associate
APPENDIX B: LADDER SAFETY POSTTEST AND ANSWER SHEET
Ladder Safety Test

Directions: USE PENCIL ONLY - do not use a pen! Please make sure your name is on the answer sheet; then select the one best answer and mark it on your answer sheet. When you have completed the test, please recheck your answer sheet to make sure you have answered all the questions and have only one answer marked for each question. If you need to erase an answer you wish to change, please make sure to erase it completely.

Part A: Ladder Parts:

1. The section of an extension ladder which may be raised or lowered is called:
   A) Tip  B) Main Section  C) Side Rails  D) Fly  E) Locks

2. The end of the ladder which rests near or on the ground is called
   A) Main Section  B) Tip  C) Safety Feet  D) Spreaders  E) Heel

3. The bottom section of an extension ladder is called
   A) Safety Feet  B) Heel  C) Spreaders  D) Main Section  E) Fly

4. The devices which hold and lock the extension section of an extension ladder are called
   A) Spreaders  B) Safety Feet  C) Fly  D) Locks  E) Side Rails

5. The devices which help prevent the ladder from slipping at the base are called
   A) Side Rails  B) Spreaders  C) Locks  D) Safety Feet  E) Heel

6. The upper end of the ladder is called
   A) Tip  B) Fly  C) Main Section  D) Side Rails  E) Spreaders

7. The devices that lock and keep a self-supporting ladder in the correct open position are called
   A) Spreaders  B) Locks  C) Safety Feet  D) Fly  E) Side Rails
8. The side pieces of a ladder which support the rungs are called
   A) Locks  B) Safety Feet  C) Spreader   D) Side Rails
   E) Fly

Part B: Ladder Types:

9. What type ladder should be used for reaching the roof of a building that is twenty-five feet high
   A) Extension Trestle Ladder  B) Tripod Orchard Ladder
   C) Straight Ladder  D) Cherry Ladder  E) Trestle Ladder

10. What type ladder should be used for reaching a light on a ceiling that is eight feet high
    A) Straight Ladder  B) Extension Trestle Ladder
    C) Cherry Ladder  D) Trestle Ladder  E) Step Ladder

11. What type ladder should be used for painting a ceiling which is ten feet high
    A) Extension Trestle Ladder  B) Step Ladder
    C) Straight Ladder  D) Cherry Ladder  E) Trestle Ladder

12. What type ladder should be used for picking apples from a tree which is thirty feet high
    A) Tripod Orchard Ladder  B) Extension Trestle Ladder
    C) Straight Ladder  D) Step Ladder  E) Cherry Ladder

13. What type ladder should be used for painting a ceiling which is thirty feet high
    A) Extension Trestle Ladder  B) Straight Ladder
    C) Trestle Ladder  D) Cherry Ladder  E) Tripod Orchard Ladder

14. What type ladder should be used for picking apples from a tree on uneven terrain which is twelve feet high
    A) Cherry Ladder  B) Extension Trestle Ladder
    C) Straight Ladder  D) Trestle Ladder  E) Tripod Orchard Ladder

Part C: Ladder Length and Placement: Please refer to the below diagram when answering questions 15 thru 18. Use the rules of thumb to determine your answers.

15. The minimum length of ladder you could use to reach the top support (distance B) would be:
    A) 19 ft.  B) 20 ft.  C) 21 ft.  D) 22 ft.  E) None of these
16. The distance the bottom of the ladder needs to be out from the building (distance A) would be:
   A) 4.75 ft.  B) 5.25 ft.  C) 5.75 ft.  D) 6.25 ft.
   E) None of these

17. The minimum top extension for access to the roof (distance C) would be:
   A) 2.5 ft.  B) 3.0 ft.  C) 3.5 ft.  D) 4.0 ft.
   E) None of these

18. The minimum length extension ladder that you could use to reach the top landing (distance B plus C) would be:
   A) 24 ft.  B) 25 ft.  C) 26 ft.  D) 27 ft.  E) None of these

20 ft. high

Part D: True - False Safety Statements:

19. Visual inspection of a ladder is an important part of ladder safety.

20. A ladder can be used at an incorrect slope provided it is securely tied or someone is holding it.

21. Under unusual conditions, a ladder may be used in a horizontal position for a short time.

22. A ladder that is too short may be placed on a box to gain additional height.

23. The heel of the ladder should be directly below the tip of the ladder as viewed from behind if the ladder is positioned correctly.
24. When using a ladder on uneven ground, a block of wood large enough to provide stability may be used under the ladder side rail to give stability to the ladder.

25. When standing erect with your toes against the ladder heel and your arms extended straight out, if your finger tips touch the rungs of the ladder, the heel should be moved out from the building.

26. Extension ladders should be adjusted only when the ladder is in a vertical position and the person doing the adjusting is on the ground.

27. A ladder that falls at a window location cannot be used. You are going to have to get either a longer or shorter ladder.

28. If a ladder is placed before a doorway that opens towards the ladder, the door should be locked or someone should guard it.

29. Rubber-soled shoes are necessary for climbing a ladder.

30. Ladders with safety shoes do not have to be secured even when used on slippery surfaces.

31. One should climb a ladder by facing it and holding on with both hands.

32. It is allowable to carry heavy tools up a ladder, if a rope and bucket are not available, as long as you can still hold on with one hand.

33. If you are in a hurry, you are permitted to come down a ladder faster by skipping rungs.

34. If the ladder is a little short, you are permitted to work from the top rung provided you have good balance.

35. Reaching out from the ladder is permissible as long as you can still hold on with one hand.

36. It is permissible to use a leg-lock while on a ladder and thus have both hands free to work with.

37. Working in a strong wind while on a ladder is not a safe practice.
38. Metal ladders can be used safely near electrical conductors.

39. A step ladder should be in the fully open position before climbing.

40. Two short ladders may be spliced together to make one longer one.

41. The fly section of an extension ladder should be on top of the main section before climbing.

42. When carrying a ladder, the tip should be slightly elevated.

43. Paint is recommended as a protective coating for wood ladders.

44. When transporting ladders on a vehicle, they should be securely attached and supported.
The Ohio State University  
OFFICE OF TESTING & EVALUATION

Print all required information in appropriate boxes. Then darken matching grids below.

<table>
<thead>
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<th>YOUR LAST NAME</th>
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<th>INSTRUCTOR</th>
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<th>CAMPUS</th>
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APPENDIX C: QUESTIONNAIRE FORMS
Ladder Safety Unit

1. Prior to teaching this unit, how would you have rated your knowledge and experience in ladder safety:
   ( ) Poor ( ) Fair ( ) Good ( ) Excellent

2. Please indicate to the nearest 1/4 hour the amount of class time used in teaching this unit: _______ hour/s

3. Please indicate to the nearest 1/4 hour the amount of time you spent for class preparation in teaching this unit:
   _______ hour/s

4. Please indicate below the source/s of information you used in planning and teaching this unit:
   ( ) Ups and Downs - The Basic Principles of Ladder Safety
   ( ) Ladder Parts Mimeograph
   ( ) Ladder Safety and You
   ( ) Ladder Safety Poster
   ( ) Ladder - Types, Use, Care
   ( ) Suggestions for Care and Use of Ladders Mimeograph
   ( ) Previous knowledge and experience
   ( ) Other (Please List)

*Questionnaire given to teachers in all groups.
5. In your opinion, has there been any situations arise prior to or during the unit which might cause your students to be more aware or interested in safety than normal: _____Yes _____No If "yes" please explain below:
Please indicate to the nearest 1/4 hour the amount of time you spent outside of class studying ladder safety: _____hour/s. If none, please place a zero in the blank.*

Did you use the booklet entitled, "Ups and Downs - The Basic Principles of Ladder Safety" in your study of ladder safety? _____Yes _____No

*3 x 5 card given to students in the "Treatment A" group.
Please indicate to the nearest 1/4 hour the amount of time you spent outside of class studying ladder safety: _____hour/s. If none, please place a zero in the blank.*

*3 x 5 card given to students in the "Treatment B" and "Control" groups.
APPENDIX D: LETTER ASKING SCHOOLS FOR THEIR
PARTICIPATION IN THE STUDY
April 22, 1975

Mr. Joe A. Gliem  
Department of Agricultural Education  
777 Columbus Avenue, Room 8-D  
Lebanon, Ohio 45036

Mr. James Smith  
Vocational Agricultural Instructor  
Marion High School  
123 Main Street  
Marion, Ohio 43206

Dear James:

We would like to take this opportunity to ask you for your help and cooperation in conducting a research project during the remaining few days of this school year. This project is concerned with teaching students toward accomplishment of previously stated student objectives, consequently, we would like for you to teach a short 2-3 day ladder safety unit to your sophomore students during the week of May 19th. References and other materials needed for the project will be provided thus we ask only that you give graciously of your time and help by teaching the unit.

A postcard is enclosed on which you may indicate your desire as to participation in the project. Should you agree to help with this project, you will notice that we have asked you to indicate date and time when we can contact you regarding further instructions. As you have probably concluded, we would prefer calling you on the weekend of May 3rd and 4th, as this allows for lower telephone rates; however, should this be inconvenient for you, please indicate another date and time for us to call. We would ask that you please return the postcard by May 2nd, indicating your desire toward participation.

In case you are beginning to wonder, your teaching is not a factor being evaluated, thus please put your mind at ease. Likewise, we are not evaluating your school, for all data will be grouped together causing schools and individuals to lose their identity. Please relax assured that we want you to be the experimenter and not the subject, thus will you kindly give of your time and talents, and check the postcard indicating your
willingness to participate in the project. We thank you in advance for your help and cooperation.

Sincerely yours,

Joe A. Gliem, Instructor
Department of Agricultural Education

Ralph E. Bender, Professor & Chairman
Department of Agricultural Education

JAG:cs
APPENDIX E: STUDENT OBJECTIVES
Student Objectives for Ladder Safety Unit

The student should be able to do the following after completing this unit:

1. Select the appropriate type ladder for a particular job.
2. Determine if each part of a ladder is sound and functioning properly.
3. Use a ladder so as to prevent injury to himself, other people, or property.
4. Maintain a ladder to prevent ladder failure.
5. Store a ladder to prevent deterioration.
6. Identify situations that could result in ladder failure or accidents.
7. Transport a ladder to prevent damage or accident to the ladder, himself, other people, or property.
APPENDIX F: LADDER SAFETY MATERIALS
LADDER PARTS

Before using a ladder, you should become familiar with its different parts and their functions. As you study the following definitions and illustrations, you will see that the parts on different types of ladders are quite similar in nature. See Figures 1, 2, and 3.

Parts of the Ladder

1. Backlogs: The legs on the back of a self-supporting ladder that give it stability and aid in its ability to carry a load.
2. Braces: Devices that give additional support to the ladder to insure greater safety to the user.
3. Fly: A section of an extension ladder which may be elevated by extending it out of the main section. There may be more than one fly section in one ladder.
4. Guides: Wooden or metal strips on an extension ladder which guide the fly section while it is being elevated.
5. Halyard: The rope or cable used to elevate the fly sections of an extension ladder. Not all extension ladders are so equipped.
6. Heel: The end of the ladder which rests on the ground.
7. Locks: Devices which hold and lock the fly section in position when it is extended. Also called pawls or dogs.
8. Main Section: The bottom (bed) section of an extension ladder.
9. Pulley: A small grooved wheel used to guide the halyard.
10. Rungs: Crosspieces between the side rails, by means of which the ladder is climbed. Also called steps or cleats.
11. Safety feet: Devices that help prevent the heel of the ladder from slipping.
12. Shelf: A device intended to support tools while working.
13. Side Rails: The side pieces of a ladder which support the rungs and which may be either solid or trussed. Also called the beam.
14. Spreader: A mechanical device found on self-supporting ladders to keep the backlegs in the correct open position for maximum stability and safety.
15. Stops: Limiting devices which prevent the fly section from being overextended when elevated, or retracted beyond its proper position when nested into the main section.
16. Tie-rods: Small diameter steel rods beneath the rungs that help prevent spreading of the side rails. These rods also serve the additional function of absorbing the shock and strain of an individual should the rung or step break.
17. Tip: The upper end of the ladder as opposed to the heel.
18. Top brace: Serves to secure the top, side rails, and backlegs together into one unit.
Figure 1. Extension Ladder.

Figure 2. Type I. Step Ladder.

Figure 3. Enlarged Section of an Extension Ladder.
Built to **USASI**
Safety Standards

**WHAT THIS MEANS TO YOU!**

**A CERTIFIED LADDER**

The American Ladder Institute, a trade organization of ladder manufacturers, in cooperation with The United States of America Standards Institute has established minimum construction specifications known as USA A14.1 (Wood) and USA A14.2 (Metal) Safety Codes for Portable Ladders. These codes are intended to prescribe rules and requirements for construction, care and use of all ladders to insure reasonable safety.

The National Safety Council suggests to all users of ladders that only such ladders known to be safe be employed and recommends these specifications.

**FOR YOUR PROTECTION**
These services are at work

**ALI** AMERICAN LADDER INSTITUTE
Chicago, Illinois 60611

**NSC** NATIONAL SAFETY COUNCIL
Chicago, Illinois 60611

**USASI** UNITED STATES OF AMERICA
STANDARDS INSTITUTE
New York, New York 10016

**how to care for ladders**

**INSPECTION**
Ladders should be inspected frequently and those which have developed defects should be either repaired or destroyed.

**CARRYING**
Always carry a ladder over your shoulder with front and elevated. Be sure not to drop or let fall for such impact weakens a ladder.

**STORAGE**
Store horizontally on supports to prevent sagging. Do not store near heat or expose to elements.

**SUGGESTIONS FOR SELECTION, CARE AND USE OF ALL LADDERS TO BRING MAXIMUM SAFETY**

Published jointly by American Ladder Institute and the National Safety Council Chicago, Illinois
or
stay on the
ground

ACCIDENTS HAPPEN WHEN . . . A ladder that should have been replaced is used . . . the wrong kind of ladder intended for a different purpose is employed . . . a safe ladder is improperly used. The American Ladder Institute and The National Safety Council suggest the following simple instructions in the selection, care and use of ladders to save you from injury and expense.

THERE'S A TESTED AND APPROVED LADDER FOR EVERY PURPOSE

Many ladder accidents occur because few users bother to learn and some employers fail to teach safe climbing methods in the use of this simple tool. There are various types of ladders designed to do a particular job better, easier and safer. Your ladder supplier can recommend the right ladder for every job. A ladder should always be inspected before each use.

FOR YOUR SAFETY

Extension ladders consist of two or more sections. The amount of "overlap" for safe use is shown below. Sketch shows vertical point where top section rests against building and indicates correct positioning of ladder at base. Angle of ladder should be such that the horizontal distance at the bottom is one-fourth the extended length of the ladder.

NECESSARY OVERLAP for SAFE USE (Two Section Extension)

<table>
<thead>
<tr>
<th>Ladder Length</th>
<th>Proper Overlap</th>
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<tbody>
<tr>
<td>Up to and including 36'</td>
<td>3 ft.</td>
</tr>
<tr>
<td>Over 36' up to and including 48'</td>
<td>4 ft.</td>
</tr>
<tr>
<td>Over 48' up to and including 60'</td>
<td>5 ft.</td>
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STEP LADDERS

Safety Standards establish the following three types designed for specific use:

TYPE I - INDUSTRIAL for construction and industry heavy-duty use.

TYPE II - COMMERCIAL for maintenance work, readjustable service.

TYPE III - HOUSEHOLD intended for light service around the home.

Ladders of ALL members are identified by label as to Type and Service. Select only step ladders on the basis of intended use.

DO'S
1. Work facing ladder and hold on with both hands.
2. Secure ladder so it will not blow down.
3. Face ladder when ascending or descending.
4. Hook leg over rung if necessary to work with both hands.
5. Make sure step ladder is fully spread and locked.

DON'TS
1. A ladder is meant to carry only one person.
2. Never stand on top of a step ladder.
3. Don't climb when shoes are muddy or wet.
4. Do not test ladders. It may damage kick rails.
5. Extension and single ladders are not designed for use in a horizontal position.

THINK OF SAFETY FIRST!

FOR SAFE USE OF LADDERS SEE ILLUSTRATIONS INSIDE
Here's the easy and proper way to erect a ladder safely

right

wrong

A ladder is a simple tool . . . use it with care!
THERE'S A RIGHT WOOD OR METAL LADDER FOR EVERY JOB

Be sure the ladder he sells, you bears this label.

The circle and triangle of the ALL seal identifies a quality ladder in either wood or metal. It has been constructed to meet specifications of the SASS Standards Institute (A14.1 and A14.2). This is your assurance of outstanding quality.

"DON'T TEST THAT WOOD LADDER"

Forest Products Laboratory, a division of the U.S. Department of Agriculture, says: "There is no simple and satisfactory method for proof-testing wood and test-loading may damage side rails".

DO NOT STAND ON TOP OF A STEPLADDER

Grip ladder firmly in climbing or descending. Wrap leg around rung when you are working. Set ladder where work can be reached with ease. Never lean too far to one side. With ladder of proper length, user can always work more safely and conveniently. Top of ladder should extend above the edge of roof by at least three feet.

right

All supporting points of step-ladder should be level. Brace uneven points as shown.

When ground is soft or footing is uneven under one side of extension ladder, brace as shown.

Be sure shoes and rungs are free of mud or grease. Place feet squarely on rung.

Uncomfortable working, and weight of user is unevenly distributed, causing overload.

Top of a stepladder is not meant for standing. There is always danger of losing one's balance.

When ladder is too short, it is unsafe and difficult to get onto roof and back again.

wrong
FALLS ARE Seldom FREE

They usually cost you the loss of your money, equipment, time, severe injury, or your life.
types • use • care
INTRODUCTION

Portable ladders are indispensable tools in many areas of human activity. They are in almost constant use in construction, maintenance and repair, warehousing and storage, orchard harvest, and other services.

Portability causes some problems and conflicts in safety programs, and calls for special attention to ladder management by safety-minded persons to avoid accidents and injuries.

Two leading problems concerning portable ladders are (1) weight, and (2) size.

Buyers and users of ladders usually insist on lightest weight possible, size for size. To be a safe tool throughout its useful life, a portable ladder must be kept in near-new condition to maintain safety margins of strength sufficient for the job.

The Safety Code governs minimum width between side rails, and minimum size of stock for steps or treads. Most ladders are built to these minimums to save weight. Foot space is adequate but, near the ladder top, there is small margin. Care must be used to keep balance and avoid falls.

The special problems of portable ladders require alertness, caution, and good judgment in ladder selection, care, handling and use if ladder accidents are to be reduced or eliminated.

This handbook is intended as a ready reference and answer book for general ladder problems and questions. It complements, but does not replace, the official document, Oregon Safety Code, Chapter 19, "Safety Code for Ladders and Scaffolds," eff. 8/1/61. The 3-part numbers (00-0-00) refer to paragraphs in the Code.

This booklet is produced by Accident Prevention Division of the Workmen's Compensation Board to promote safer use of portable ladders.
CONTENTS

SINGLE PORTABLE OR STRAIGHT LADDER
EXTENSION STRAIGHT LADDER
CHERRY OR "SPIKE" LADDER
ORCHARD EXTENSION LADDER
STANDARD STEP LADDER
TRIPOD ORCHARD LADDER
TRIPOD ORCHARD LADDER DOUBLE BASE
INDUSTRIAL STEP LADDER
PAINTERS' TRESTLE LADDER
EXTENSION TRESTLE LADDER
LADDER SELECTION
LADDER USE
LADDER TRANSPORTATION
LADDER STORAGE
GENERAL RECOMMENDATIONS
LADDER MAINTENANCE AND REPAIR
IMPROVING SLIP RESISTANCE
SINGLE PORTABLE (or STRAIGHT) LADDER

Most common type.
Widest range of applications.
Indispensable for general use in various locations.

Required safety additions:

1. Rubber or neoprene shoes for smooth, dry surfaces (19-1-29).
2. Cord-face shoes for wet, slippery surfaces (19-1-29).
3. Spikes needed for icy or snowy footing (19-1-29).
4. Otherwise firmly secured.
5. Cleats shall be firmly and properly attached (19-2-44).

One section
Max. Length — 30 ft.
Capacity — 1 person
Wood or Metal
Design provides greatest allowable length for general purpose ladder.

Stops shall be installed to insure required overlap (19-3-5).

Guide irons and construction shall develop strength equal to ladder of same length fabricated of continuous side rails (19-3-8).

Recommended safety equipment:

1. Rubber or neoprene ladder shoes for smooth dry floor surface.

2. Cord-face shoes for wet, slippery surface.  
   Note: Combination rubber or neoprene cord shoes available.

3. Apply steel spikes for icy or snowy footing.

4. Otherwise firmly secured.

Wood—2 sect. Metal—3 sect.

Max. Length—60 ft.

Overlap: To 36 ft. incl.—3'  
   Over 36 ft. to 48 ft. incl.—4'  
   Over 48 ft. to 60 ft.—5'

Wood or Metal

Capacity — 1 person
CHERRY or "SPIKE" LADDER

Converging rails designed for placement in limb crotch.

Stability enhanced by virtual one-point top bearing contact.

Standard factory manufacture provides doubled base to retard excessive uneven penetration.

Optional equipment:

1. Steel "Spikes" to prevent base slipping or skidding.

2. Rubber sleeves for upper rail sector to reduce branch abrasion and possibility of slip along limb.

One Section

Max. Length - 30 ft.

Capacity - 1 person
ORCHARD EXTENSION LADDER

Has converging rails at top for easy fit in limb crotch.

Virtual one-point top bearing increases stability.

Selected optional equipment items listed on Cherry Ladder type sheet are applicable.

2 Section

Max. Length — 60 ft.

Overlap:  To 36 ft. incl. — 3'
   Over 36 to 48 ft. incl. — 4'
   Over 48 to 60 ft. — 5'

Capacity — 1 person
STANDARD STEP LADDER

General purpose, self-supporting portable ladder.
Also manufactured for special applications, as extra-strength for heavy duty and industrial service.
Use limited to firm, level footing, as floors, platforms, slabs.
Step-ladder top shall not be used as step (19-3-26).

Required equipment:
1. Metal spreader or locking arms (19-3-27).
2. Insulating non-slip shoes on metal ladders (19-4-7).

4-leg rigid
Max. Length — 20 ft.
Wood or Metal
Capacity — 1 person
TRIPOD ORCHARD LADDER

For use on soft and uneven terrain.

Use should be restricted to pruning and harvest operations.

Step ladder top prohibited as step (19-3-26).

Spreaders, locking devices, steel points, safety shoes are not required (19-3-87).

Not a general purpose ladder; recommend restricting use to orchards.

Special Features:

1. Single back leg provides relatively stable support on uneven terrain.

2. Steps 27 in. or more in length shall be provided with metal angle brace (19-3-82).

3. Maximum flare on rails top-to-bottom required to enhance stable base, average 2¾ in. per ft. (19-3-84).

4. Doubled base on rails or mitered metal flange provided to control excessive penetration in soft soil.

Max. Length — 16 ft.

Wood or Metal

Capacity — 1 person
TRIPOD
ORCHARD LADDER
DOUBLE-BASE

Notes and special features descriptive of Tripod Orchard Ladder (preceding page) apply to the Double Base Tripod Ladder.

Additional Note:
Triangular box brace effect obtained by stub rails, and terminating laddet rails on bottom step provides rigidity and durability approved by many orchardists.

Max. Length — 16 ft.
Wood, or combination
Wood Rail — Metal Step
Capacity — 1 person
INDUSTRIAL STEP LADDER

Designed for heaviest service demands.

Oversize back legs and heavy duty flat steps for second worker-helper as aircraft and glazing.

Special Feature:

Metal knee braces to increase rigidity and durability.

Max. Length -- 20 ft.
Capacity -- 2 persons
PAINTERS TRESTLE LADDER

Max. Length — 20 ft.
Capacity — Designed to be used in pairs to support planks or staging.

Not intended primarily to work from while standing on rungs.

Rungs with 12-inch spacing are staggered to provide 6-inch levels for planks or staging.

Requirements:

1. Angle of spread between front and back legs, in open position, shall be 5½ in. per ft. of length (19-3-42).

2. Rail tops shall be beveled, and equipped with metal hinge to prevent spreading (19-3-43).

3. Metal spreader or locking device shall be a component (19-3-44).
EXTENSION TRESTLE LADDER

Comments on Painters' Trestle apply to Extension Trestle.

Requirements:

1. Lap of extension section into base section shall be not less than 3 ft. (19-3-5).

Max. Length, each section — 20 ft.

Capacity — Designed to be used in pairs to support planks on staging.
LADDER SELECTION

Reference to preceding section on Ladder Types emphasizes the wide range of designs developed for various tasks.

There are, in addition, many special-purpose ladders not shown, such as platform, trolley, side-rolling, citrus, shaft, sectional, manhole, etc. A real reason exists for such variety; in a phrase—"proper tool selection for best job performance."

Principles of maintenance, storage, and skid-resistant treatment apply to the special-purpose ladders as well as to those illustrated in this handbook.

It is not the intent of the Oregon Safety Code or this publication to restrict ladder use to jobs described by type name indicating "best use." Nevertheless, real economies often can be realized by using the right type for the job. Two examples are cited to illustrate possible results of wrong use:

1. A medium-duty, four legged step ladder, designed for use on firm, level footing, if used on soft, uneven terrain encountered in orchard work, can be racked and twisted in a short time until unfit for any service. The user also risks injury from the unstable support.

2. A tripod orchard ladder, lacking locking arms or spreaders, when used on firm, smooth footing, tends to have the tripod leg or pole creep forward. This leads to total collapse, and may cause damage to the ladder, and serious injury to the user. Orchard ladders should without question be limited to orchard work.
A. At Beginning of Each Job or Season:
   DO —
   1. Select clean, dry ladders.
   2. Make certain of no cracked or broken rails, steps, rungs or hardware.
   3. Inspect for firm, tight condition, general soundness (19-1-5).
   AVOID —
   1. Wet, dirty, oily ladders.
   2. Climbing when hands or shoes are greasy or slippery (19-1-39).
   4. Painting, which may conceal defects. Use transparent preservatives (19-1-56).

B. Care in Placing Ladder:
   DO —
   1. Incline at proper angle — base out not less than one-fourth ladder length. Minimum slope is 50 degrees from horizontal (19-1-27).
   2. Place solid rest for rail tops across window opening (19-1-31).
   3. Back of orchard ladder should be aimed toward tree center; additional support is thus available in event of initial slip.
   4. Remove leg or pole of tripod ladder, which may have been placed over low limb or in trunk crotch, in a manner to avoid cracking, or buckling.
   5. Protect the base of tall, occupied ladders in traffic lanes (19-1-32).
   AVOID —
   1. Placing ladder in front of unlocked, unguarded door opening forbidden (19-1-33).
   2. Setting ladders on boxes, tables, trucks, or other moveable base prohibited (19-1-34).

C. Ascending and Descending:
   DO —
   1. Face ladder at all times (19-1-37).
   2. Grasp rails with hands to control drop in event of, rung or step failure.
   AVOID —
   1. Sliding or slipping down ladder as a time-saving act.

D. Securing Equipment Properly:
   DO —
   1. Attach tools or materials in use firmly to ladder or person.
   2. Use hand line to raise or lower large, heavy or awkward tools or materials, rather than attempting to carry such items.
   3. Use strong, adequate bail hook on picker bucket.
   4. Secure limb hook firmly to ladder or adjoining limb when not in use.
AVOID —
1. Placing on ladder steps or platform, tools or materials which may fail.
2. Use hands for carrying — keep free for climbing (19-1-38).

E. Single Use and Limited Leaning:

DO —
1. Limit standard ladder to one person (exceptions may be heavy-duty industrial ladder with steps front and back) and trestle ladder (19-1-40).
2. Erect scaffold or employ second ladder if assistance of another person is needed.
3. Move ladder near work to be done.
4. Place both feet firmly and securely on rung or step.

AVOID —
1. Excessive reaching or leaning — overbalancing, overturning.
2. Standing on one foot.

F. Securing Ladder:

DO —
1. Nail or lash ladder subjected to repeated or prolonged use in same location (19-1-29).
2. Select ladder which will extend not less than 36 inches above platform, floor, or landing to be served (19-1-30).

AVOID —
1. Working on exposed ladders during severe storm or high wind (19-1-6).
2. Working on ladders covered with ice or snow (19-1-7).
3. Continuing portable ladder in service when replacement by approved stairways is indicated (19-1-26).

G. For Metal Ladders Only:

Do —
1. Corrugate, knurl, dimple, apply skid-resistant surfacing, or otherwise treat steps or rungs to minimize possibility of slipping (19-4-2).

AVOID —
1. Using near electric current source. Legible, permanent marking shall read, "WARNING — Do not use around energized electrical equipment," or similar wording (19-4-4).

H. Common Sense Precautions:

DO —
1. Limit loading well below known ladder capacity. NOTE: Oregon Safety Code, Chapter 19, calls for strength of materials in wooden ladders which provide an adequate safety factor.

AVOID —
1. Using ladder as guy, brace or skid (19-1-36).
2. Employing as substitute for proper plank or staging.
LADDER TRANSPORTATION

1. When ladder is hand-carried by one man, front end should be elevated to clear a man's head, especially around blind corners, or in aisles and through doorways (19-1-54).

2. When loading on truck or trailer beds, reasonable care should be exercised in placing parallel for maximum support; avoid tossing, throwing or dropping with resultant nicking, galling, splintering or bending.

3. Long ladders on short truck or trailer beds, scheduled for extended haul, should be protected against sag or humping.

4. Use side stakes if available to prevent lateral swing; drive slowly over rough terrain; tie down securely to eliminate nicking, gouging, chafing and road shock (19-1-55).
1. Ladder storage area should be well ventilated.

2. Wood ladders should not be exposed to moisture or excessive heat; avoid storage near stoves, steam pipes or radiators (19-1-50).

3. Straight or extension ladders may be stored economically in flat racks or on wall brackets; if rails have lateral curve, wall brackets should match curvature, and brackets for all ladders should support at sufficient number of points to prevent sag and permanent set (19-1-51).

4. Increasingly, users of step ladders and tripod ladders are recommending near-vertical storage in the closed position, which reduces distortion strains to practical minimum, and can eliminate sag, hump, twist and rack.

5. Ladders should be returned to storage promptly after use, particularly those of wood construction. Moisture, with subsequent swelling, shrinking, checking and cracking, and accelerated decay, can rapidly shorten the useful life of an otherwise sound ladder. Sunburn, and resulting shrinkage, warping and checking, is easily the Number Two enemy of all wooden ladders.
1. Give instruction, without fail to new employees on proper use and care of ladders, and possible hazards, prior to assignment to ladder work (Basic — Part 1, Pg. 9, Rule 1.28). Failure to instruct a new employee of potential dangers has constituted negligence in Oregon Courts, following an accidental injury involving a ladder.

2. When selecting employees for orchard harvest, consideration should be given to balancing juveniles with a fair proportion of experienced adults, if possible, as a steadying and example-setting influence.

3. Special problems and liability are assumed by orchardists who employ family picking groups which include a large number of small children. In such instances effective instruction on proper ladder use is of extreme importance.

4. Orchard harvest team organization should include an experienced man, whenever possible, to simplify and expedite ladder moving.

5. A climber shall not stand on the top rung or step of any ladder, with exception of the platform ladder, which has large support area, and side rail enclosure (19-3-26).
A sound and effective plan for periodic maintenance and repair can promote safety, extend useful ladder life, and cut yearly unit costs.

Seasonal service which includes tightening step bolts and other fastenings assures tight, firm, basically new physical condition.

Lax maintenance programs or total neglect can lead to early failure; slackness in step bolts quickly develops from alternate swelling and shrinkage which follow wetting and drying. Soon all or nearly all step sockets and other joints work loose. Close fit is lost, hole sizes increase, rack and twist develop rapidly. Such ladders should be removed from service and destroyed.

Employers who use a sizable number of ladders, such as painters, roofers, and orchardists, can profit by stocking a good selection of commonly needed repair parts. These would include ladder bolts and related hardware, and lower steps or rungs which from experience have been found to wear out earlier than upper treads.

Maintaining such parts on hand speeds repair and return to service of bad-order ladders without the extra expense and delay of shopping for parts as failures occur.

Replacing lower steps on wooden ladders is recommended when approximately one-fourth worn away. Minimum wear will be in the center of the step. Mineral abrasive or other skid-resistant material (next section) reduces wear and need for step replacement.

NOTE: Cleats are not to be used to repair rung ladders (19-2-49).
Preservatives should be applied at intervals sufficient to ward off decay, and to minimize check, warp and crack.

Painting wood ladders, which may hide defects, is ruled out by Oregon Code (19-1-56).

Acceptable preservatives for wood ladders, in order of present popularity, are (1) pentachlorophenol, (2) spar varnish, (3) shellac, and (4) linseed oil.

Linseed oil, particularly the raw type, is not highly recommended, as it dries slowly, and in the tacky state collects dust and other soil, losing transparency and gaining undesirable weight.

CAUTION
IMPROVING SLIP RESISTANCE

Skid-resistant materials suitable for ladder treads have been developed and put to use in the last few years, principally on industrial applications.

Of note is anti-skid treatment of metal platform ladders for use in offices, file and parts rooms, tool cribs and frozen food lockers (19-4-2).

These materials, properly applied, increase footing over any untreated surface, but to date little activity has been observed in extending this improvement to wood ladders.

Two obvious benefits result when ladders are equipped with slip-resistant material: (1) the climber, observing the employer's effort to provide secure footing on the ladder, is reminded to exercise more caution, and (2) the added protection from slips will reduce falls and injuries.

Falls from ladders are not a major cause of accidents and injuries in Oregon, but the cost per injury involving ladders is extremely high. Use of skid-resistant materials on ladder treads is recommended by the Accident Prevention Division of the State Industrial Accident Commission.

A brief description of available materials and their application follows:

A. **Cloth-backed mineral abrasive** — available in strips, panels, and large sheets or yardage. Both adhesive-backed, pressure-sensitive type, and plain type requiring cement, are available. All may be applied to any clean, dry surface. Edge sealing (beading) compound insures a more lasting application, and should be used.

B. **Anti-slip abrasive surfacer** — a mastic-type compound containing mineral abrasive, to be applied in a thin coat by trowel. It is now supplied in gallon cans. Request may be made for quotations on larger quantities. Warranty is given for endurance under conditions of exterior-wet-dry-oily.
C. Walnut shells, coarse-ground — customarily a wall tex­

when worn smooth, may be re-dimpled by use of a tap­

red punch of selected size, driven upward in same

when worn smooth, may be re-dimpled by use of a tap­

E. Re-dimpling — metal ladder treads with round dimples.

mixed coat of spar varnish.

thinned coat of spar varnish.

of sand may be further bonded by application of a

surplus sand. Ladder may then be placed in service.

after allowing ample drying time, shake off

surface. After allowing ample drying time, shake off

steps or rungs, then still dry sand onto wet varnished

resistance. The recommended procedure is to varnish

sand — when properly applied, can promote slip.

When applying to metal steps, a damp-proof primer such as red

ladder treads surface.

nail, if has been found to provide a good slip resis­

than about one-fourth shells to three of four parts varn­

most paint stores. Mixed into spar varnish in propor­

the materials used by decorators, are available from

C. Re-dimpling — metal ladder treads with round dimples.
This booklet is issued in the interest of preserving Oregon's most precious asset... the health, well-being and lives of its citizens.

PUBLISHED BY
ACCIDENT PREVENTION DIVISION
WORKMEN'S COMPENSATION BOARD
LABOR AND INDUSTRIES BUILDING
SALEM, OREGON 97310

LIMITED ADDITIONAL COPIES AVAILABLE ON REQUEST
Suggestions for Care and Use of Ladders*

Care: To insure safety the following precautions on the care of ladders shall be observed.

1. Ladders shall be maintained in good condition at all times, the joint between the steps and side rails shall be tight, all hardware and fittings securely attached, and the movable parts shall operate freely without binding or undue play.

2. Metal bearings of locks, wheels, pulleys, etc., shall be frequently lubricated.

3. Frayed or badly worn rope shall be replaced.

4. Safety feet and other auxiliary equipment shall be kept in good condition to insure proper performance.

5. Ladders should be stored in such a manner as to provide ease of access or inspection, and to prevent danger of accident when withdrawing a ladder for use.

6. Wood ladders, when not in use, should be stored at a location where they will not be exposed to the elements, but where there is good ventilation. They shall not be stored near radiators, stoves, steam pipes, or other places subjected to excessive heat or dampness.

7. Ladders stored in a horizontal position should be supported at a sufficient number of points to avoid sagging.

8. Ladders carried on vehicles should be adequately supported to avoid sagging and securely fastened in position to minimize chafing and the effects of road shocks.

9. Ladders should be kept coated with a suitable protective material.

10. Ladders shall be inspected frequently and those which have developed defects shall be withdrawn from service for repair or destruction and tagged or marked as "Dangerous, Do Not Use."

*Reprint from Federal Register
11. Rungs should be kept free of grease and oil.

Use: The following safety precautions shall be observed in connection with the use of ladders.

1. Portable rung ladders shall, where possible, be used at such a pitch that the horizontal distance from the top support to the foot of the ladder is one-quarter of the working length of the ladder (the length along the ladder between the foot and the top support). The ladder shall be so placed as to prevent slipping, or it shall be lashed, or held in position. Ladders shall not be used in a horizontal position as platforms, runways, or scaffolds.

2. Ladders should not be used by more than one man at a time nor with ladder jacks and scaffold planks where use by more than one man is anticipated. In such cases, specially designed ladders with larger dimensions of the parts should be procured.

3. Portable ladders shall be so placed that the side rails have a secure footing. The top rest for portable rung ladders shall be reasonably rigid and shall have ample strength to support the applied load.

4. Ladders shall not be placed in front of doors opening toward the ladder unless the door is blocked open, locked, or guarded.

5. Ladders shall not be placed on boxes, barrels, or other unstable bases to obtain additional height.

6. To support the top of a ladder at a window opening, a board should be attached across the back of the ladder, extending across the window and providing firm support against the building walls or window frames.

7. When ascending or descending, the user should face the ladder.

8. Ladders with broken or missing steps, rungs, or cleats, broken side rails, or other faulty equipment shall not be used. Improvised repairs shall not be made.

9. Short ladders shall not be spliced together to provide long sections.
10. Ladders shall not be used as guys, braces, or skids, or for other than their intended purposes.

11. Tops of the ordinary types of step ladders shall not be used as steps.

12. On two-section extension ladders the minimum overlap for the two sections in use shall be as follows:

<table>
<thead>
<tr>
<th>Size of Ladder (Feet)</th>
<th>Overlap (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to and including 36</td>
<td>3</td>
</tr>
<tr>
<td>Over 36 and up to and including 48</td>
<td>4</td>
</tr>
<tr>
<td>Over 48 up to and including 60</td>
<td>5</td>
</tr>
</tbody>
</table>

13. Portable rung ladders with reinforced rails shall be used only with the metal reinforcement on the underside. Ladders of this type should be used with great care near electrical conductors, since the reinforcing itself is a good conductor.

14. No ladder should be used to gain access to a roof unless the top of the ladder shall extend at least 3 feet above the point of support, at eave, gutter, or roof line.

15. Adjustment of extension ladders should only be made by the user when standing at the base of the ladder, so that the user may observe when the locks are properly engaged. Adjustment of extension ladders from the top of the ladder (or any level over the locking device) is a dangerous practice and should not be attempted. Adjustment should not be made while the user is standing on the ladder.

16. Middle and top sections of extension ladders should not be used for the bottom section unless the user equips them with safety shoes.

17. Extension ladders should always be erected so that the upper section is resting on the bottom section.

18. The user should equip all portable rung ladders with non-slip bases when there is a hazard of slipping. Non-slip bases are not intended as a substitute for care in safely placing, lashing, or holding a ladder that is being used upon oily, metal, concrete, or slippery surfaces.
19. The bracing on the back legs of step ladders is designed solely for increasing stability and not for climbing.

20. When service conditions warrant, hooks may be attached at or near the top of portable ladders to give added security.
APPENDIX G: LETTERS OF INSTRUCTIONS
May 12, 1975

To: Vocational Agriculture Teachers teaching the Ladder Safety Unit
From: Joe A. Gliem
Regarding: Ladder Safety Unit Instructions

First, I would like to take this opportunity to thank you men for your time, help, and cooperation in teaching this unit. Without you, very little could be accomplished; thus I do want you to know that I appreciate your efforts, and extend to you my sincere thanks.

In preparation for teaching this unit, I would ask that you please observe the following instructions:

1. Do not emphasize to your students that they are in a study. I realize students are not naive; and will probably ask some questions, particularly when they begin to fill out the answer sheet for the test. However, please try being as tactful and discreet as possible with your students regarding the study.

2. Do not visit with other teachers from surrounding schools about the study. They may already be engaged in another phase of the same study, thus conversation about the study could lead to invalid results.

3. You may teach the unit by any method you desire. However, I do ask that you teach toward the accomplishment of the enclosed objectives.

4. I ask that you begin teaching the unit to your sophomores on Tuesday, May 20th. Time is not a factor, thus you may spend as much time on the unit as you feel necessary for accomplishing the enclosed student objectives.

5. Please make available to each of your students a copy of the reference entitled "Ups and Downs - The Basic Principles of Ladder Safety." You and your students must use this reference; however, you may then use any or all of the other enclosed references, as well as others you might have available, for teaching the unit.

*Instructions given to teachers in the "Treatment A" group.
To: Vocational Agriculture Teachers teaching the Ladder Safety Unit*
Page 2
May 12, 1975

If you should have questions or problems regarding the study; or if the second mailing of materials does not reach you by May 20th, please contact me at (513) 932-5623.

Once again, my sincere thanks to you for your contribution toward this study.
To: Vocational Agriculture Teachers teaching the Ladder Safety Unit*

From: Joe A. Gliem

Regarding: Ladder Safety Unit Instructions

First, I would like to take this opportunity to thank you men for your time, help, and cooperation in teaching this unit. Without you, very little could be accomplished; thus I do want you to know that I appreciate your efforts, and extend to you my sincere thanks.

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2. Do not visit with other teachers from surrounding schools about the study. They may already be engaged in another phase of the same study, thus conversation about the study could lead to invalid results.

3. You may teach the unit by any method you desire. However, I do ask that you teach toward the accomplishment of the enclosed objectives.

4. I ask that you begin teaching the unit to your sophomores on Tuesday, May 20th. Time is not a factor, thus you may spend as much time on the unit as you feel necessary for accomplishing the enclosed student objectives.

5. You must use the reference entitled "Ups and Downs - The Basic Principles of Ladder Safety." However, you may then use any or all of the other enclosed references, as well as others you might have available, for teaching the unit. Please do not let your students use the reference entitled "Ups and Downs - The Basic Principles of Ladder Safety."

*Instructions given to teachers in the "Treatment B" group.
To: Vocational Agriculture Teachers teaching the Ladder Safety Unit*
Page 2
May 12, 1975

If you should have questions or problems regarding the study; or if the second mailing of materials does not reach you by May 20th, please contact me at (513) 932-5623.

Once again, my sincere thanks to you for your contribution toward this study.
May 12, 1975

To: Vocational Agriculture Teachers teaching the Ladder Safety Unit

From: Joe A. Gliem

Regarding: Ladder Safety Unit Instructions

First, I would like to take this opportunity to thank you men for your time, help, and cooperation in teaching this unit. Without you, very little could be accomplished; thus I do want you to know that I appreciate your efforts, and extend to you my sincere thanks.

In preparation for teaching this unit, I would ask that you please observe the following instructions:

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2. Do not visit with other teachers from surrounding schools about the study. They may already be engaged in another phase of the same study, thus conversation about the study could lead to invalid results.

3. You may teach the unit by any method you desire. However, I do ask that you teach toward the accomplishment of the enclosed objectives.

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5. You may use any or all of the enclosed references, as well as others you might have available, for teaching the unit.

If you should have questions or problems regarding the study; or if the second mailing of materials does not reach you by May 20th, please contact me at (513) 932-5623.

*Instructions given to teachers in the "Control" group.
To: Vocational Agriculture Teachers teaching the Ladder Safety Unit*
Page 2
May 12, 1975

Once again, my sincere thanks to you for your contribution toward this study.
APPENDIX H: LETTER GIVING INSTRUCTIONS FOR COMPLETING

THE DATA GATHERING INSTRUMENTS
May 15, 1975

To: Vocational Agriculture Teachers teaching the Ladder Safety Unit
From: Joe A. Gliem
Regarding: Instructions for second mailing of materials

In this mailing, you should have the following materials:

1. Questionnaire - please answer all questions as accurately as possible. On question 4, please indicate only the source/s of information from which you took information to present to the class. Do not indicate the source/s that you just thumbed through or glanced at briefly.

2. Tests and Answer Sheets - There should be enough tests and answer sheets for each student. On the answer sheets, please make sure that students use pencil only; do not allow them to use a pen! Please see that they put their name on the answer sheet; and then, have all students read the directions at the top of the safety test before beginning the test. The other information asked for on the answer sheet need not be filled out.

3. 3 x 5 cards - please separate the cards and give them to your sophomore students after they finish the test. Ask them to be as accurate as possible in their reply; then pick up the cards without having the student put his/her name on the card.

4. Self-addressed, stamped envelope - please return to me as soon as possible the completed questionnaire, answer sheets, and cards. Those of you that have sophomore classes composed of students other than sophomores, treat the class as if it were all sophomores; but only send to me the answer sheets and cards from your sophomore students.

If there are any questions or problems, please get in contact with me at (513) 932-5623.
Once again, I would like to thank you men for your time and help on this project. Without you, it would have been impossible to complete. If I can ever be of help to you, please do not hesitate on getting in contact with me.